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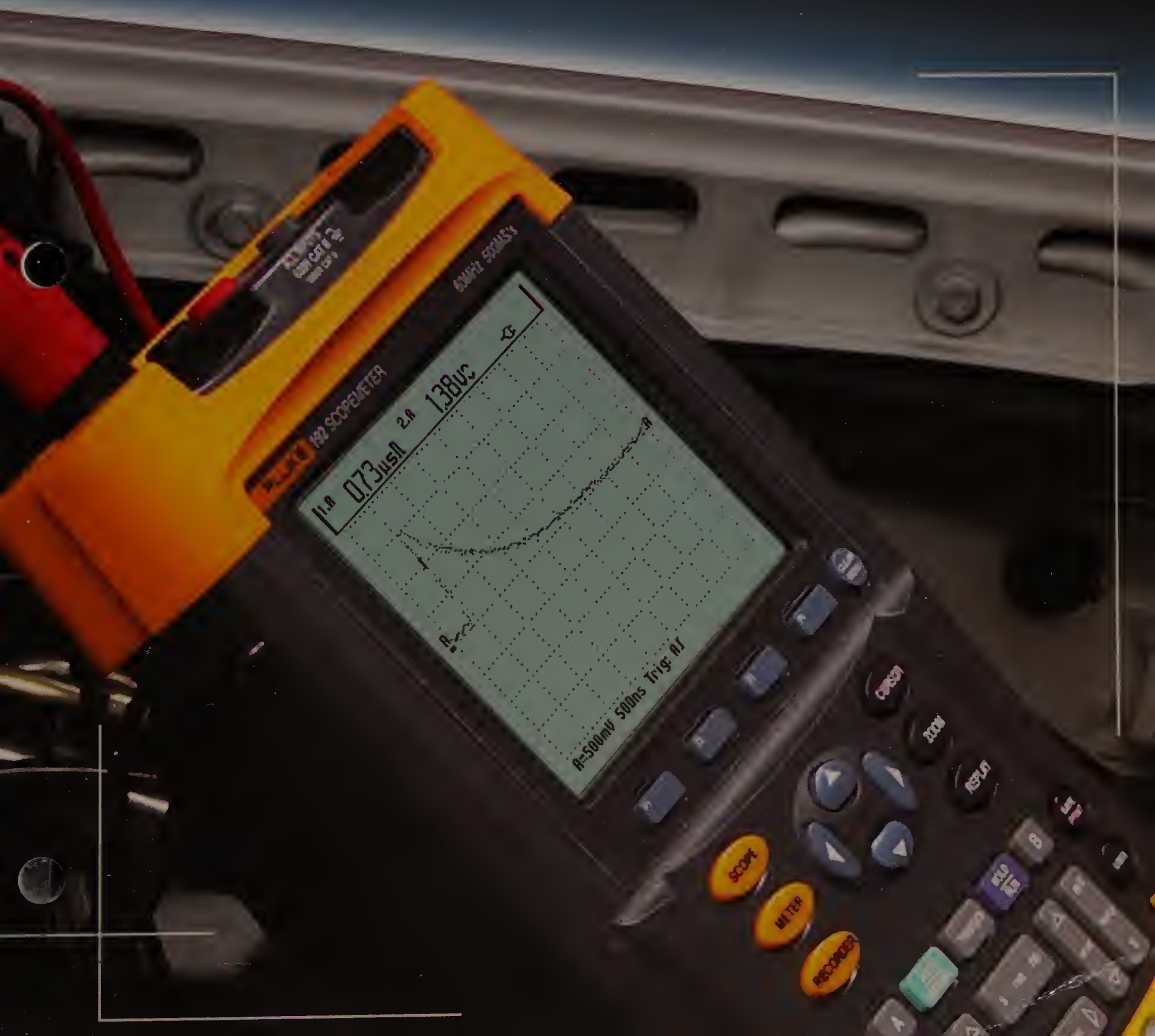
Preparation for Certification

A6

Workbook
Auto Electricity and Electronics

Nancy Henke-Konopasek James E. Duffy



2009

Workbook for

Auto Electricity and Electronics

Principles, Diagnosis, Testing, and Service of All Major Electrical, Electronic, and Computer Control Systems

by

N. Henke-Konopasek
Munster, Indiana

and

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Crown Point, Indiana

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Introduction

The **Workbook for Auto Electricity and Electronics** is designed to improve your understanding of the material in the **Auto Electricity and Electronics** textbook. It highlights important subject matter and simplifies the text by requiring you to complete several different types of learning exercises.

Each workbook chapter serves as an "open book" test that covers the content of the corresponding textbook chapter. You must answer several types of questions as you read and study the text. As a result, the workbook also serves as a study guide, making sure you more fully comprehend the most important information.

The workbook contains conventional word-type problems: completion, short answer, multiple choice, identification, and matching. It also uses numerous illustration-type problems that require you to identify parts and actions, and sometimes to draw in missing components, wires, arrows showing flow, etc. This balance between word and illustration problems will help you learn and stay interested in your study of automotive technology.

This workbook also contains a sample ASE-type test. The questions in this test relate to ASE Certification Test A6, Electrical/Electronic Systems, as well as to the information given in the textbook. The sample test will help prepare you for the actual certification tests and show your strengths and weaknesses in this area of service.

The jobs contained in this workbook are hands-on activities in component inspection, testing, problem diagnosis, service, and repair. They are designed to give you a chance to apply what you have learned throughout the **Auto Electricity and Electronics** textbook. The workbook jobs are not correlated to specific textbook chapters, but will be assigned when your instructor determines that you have sufficient knowledge to complete them. When performing the jobs, follow the instructions carefully and proceed through the steps in the order that they are presented. Record the results of all diagnostic procedures when required.

As a student of automotive technology, you should find this workbook to be a very useful "learning tool." By restudying your answers, you can use it as a guide to prepare for instructor and certification tests.

N. Henke-Konopasek

J. Duffy

Instructions for Answering Workbook Questions

Each chapter in this workbook directly correlates to the same chapter in the text. Before answering the questions in the workbook, study the assigned chapter in the text and answer the end-of-chapter review questions. Then, review the objectives at the beginning of each workbook chapter. This will help you review the important concepts presented in the chapter. Try to complete as many workbook questions as possible without referring to the textbook. Then, use the text to complete the remaining questions.

A variety of questions are used in the workbook including multiple choice, identification, completion, and short answer. These questions should be answered in the following manner:

Multiple Choice

Select the best answer and write the correct answer in the blank.

1. If the top of the battery is dirty, wash it down with:
   (A) baking soda and water.
   (B) vinegar.
   (C) soap and water.
   (D) Either (A) or (C).

1. (D) Either (A) or (C).

Completion

In the blank provided, write the word or words that best complete the statement.

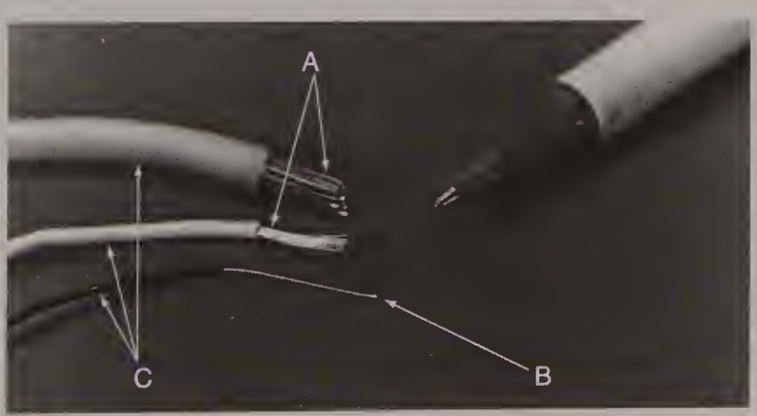
2. A(n) _____ wire should never be used to bypass a high resistance component, a fuse, or a circuit breaker.

2. jumper

Identification

Identify the components indicated on the illustration or photograph accompanying the question.

3. Identify the types of wires shown below.



3. (A) Stranded wire conductor.
   (B) Solid wire conductor.
   (C) Wire insulation.

Short Answer

Provide complete responses to the statements.

4. Explain why, quite often, an ignition control unit problem will show up after a period of engine operation.

Engine heat will soak into the module, raising its temperature. The heat will upset the operation of the electronic components in the unit.

Matching

Match the term in the left column with its description in the right column. Place the corresponding letter in the blank.

Match the following parts of matter with their descriptions.

5. Atom D
6. Element B
7. Molecule A
8. Compound C

(A) A small group of different elements.

(B) A group of one type of atoms.

(C) A group of different molecules.

(D) The smallest particle in matter.

Other Types Of Questions

When other types of workbook questions are presented, follow the specific instructions that accompany the problem.

Name _____

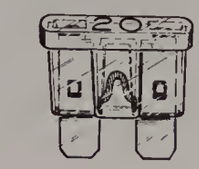
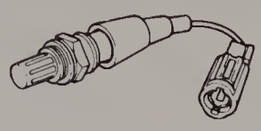
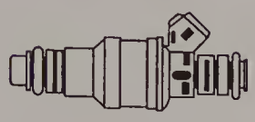
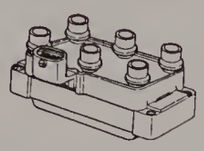
Date _____

Instructor _____

Score _____ Text pages 7–18

Chapter 1

Introduction to Electrical-Electronic Systems

After studying this chapter and completing supplemental exercises, you will be able to:

- Explain why electronic devices are being used to increase vehicle efficiency.
- Summarize the operation of major electrical-electronic systems of an automobile.
- Describe the basic parts of major electrical-electronic systems.
- Locate major electrical-electronic components.
- Explain how modern automotive systems interact.
- Describe the purpose of a computer control system.
- Comprehend later textbook chapters more completely.

Instructions: As you study Chapter 1 of the text, complete the following workbook problems in the spaces provided.

The Electronic Revolution

1. _____ are being used to monitor and control almost all critical assemblies in cars.

1. Computers

2. Describe the difference between an electrical device and an electronic device.

Electrical - Of, relating to, producing, or operated by electricity
Electronics - Systems involving the flow of electrons in a vaccum and semiconductors

3. Explain why electrical devices have replaced many mechanical devices in automobiles.

More efficient

4. The electrical-electronic devices used in the many systems of a car are diagnosed and repaired by a specialized technician known as a(n) _____ _____ .

4. _____

5. What is necessary if you are to properly troubleshoot and repair today's complex, interacting vehicle systems?

The Computer Network

6. Define the term *computer network.*
A set of computers connected together for the purpose of sharing the resources

7. Describe the three basic components of the computer network or computer system.
(A) *Vehicle sensors:* A device that measures or detects real world conditions
(B) *Computer:* An an eletronic device for storing and processing data
(C) *Actuators:* A [illegible] machines that is responsible for moving or controlling a mechanism or system

8. The "eyes, ears, and nose" of the computer network are the _____ _____. 8. _____

9. The car's _____, or electronic control unit, is a super-complex set of electronic circuits that use sensor inputs to produce programmed (predetemined) outputs. 9. _____

10. A(n) _____ is a device that uses electrical energy and engine vacuum, pressure, or a combination of each to do work. 10. _____

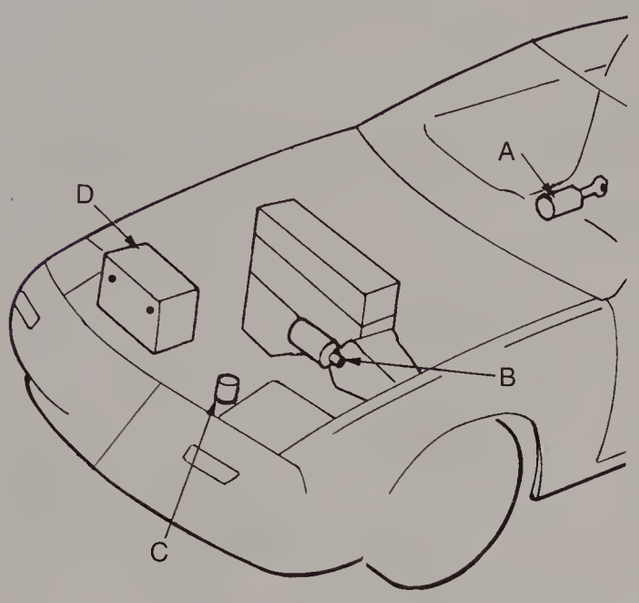
11. _____-_____ _____ refers to a vehicle computer's ability to analyze the operation of its circuits and to output data showing any problems. 11. _____

The Starting System

12. The starting system uses battery power and a powerful _____ _____ to rotate the engine crankshaft. 12. _____

Name _____

13. Draw in the wiring that connects the four major components of the starting system. Then identify the parts indicated on the diagram below.



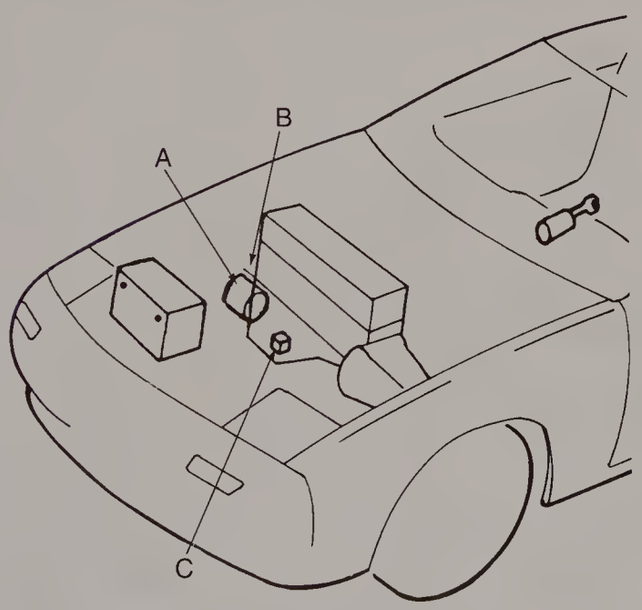
13. (A) Ignition switch
(B) Starter
(C) Solenoid
(D) Battery

Charging System

14. The charging system forces current back through the _____ for recharging, provides electricity for all of the electrical devices when the engine is running, and serves as the "electrical power supply."

14. Battery

15. Draw in the wiring that connects the parts of the charging system. Then identify the parts indicated on the diagram below.



15. (A) Alternator
(B) regulator
(C) _____

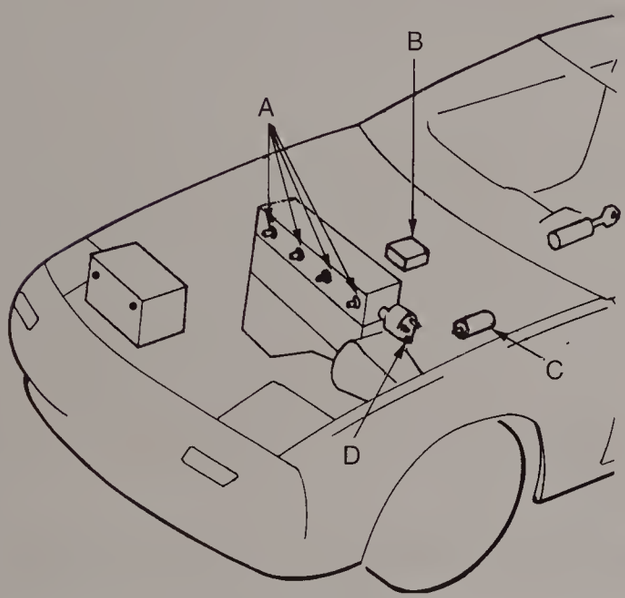
Ignition System

16. The ignition system is needed on gasoline engines to

Start the engine

17. Draw in the wiring that connects the parts of the ignition system. Then identify the parts indicated on the diagram below.

17. (A) _____
(B) _____
(C) _____
(D) _____



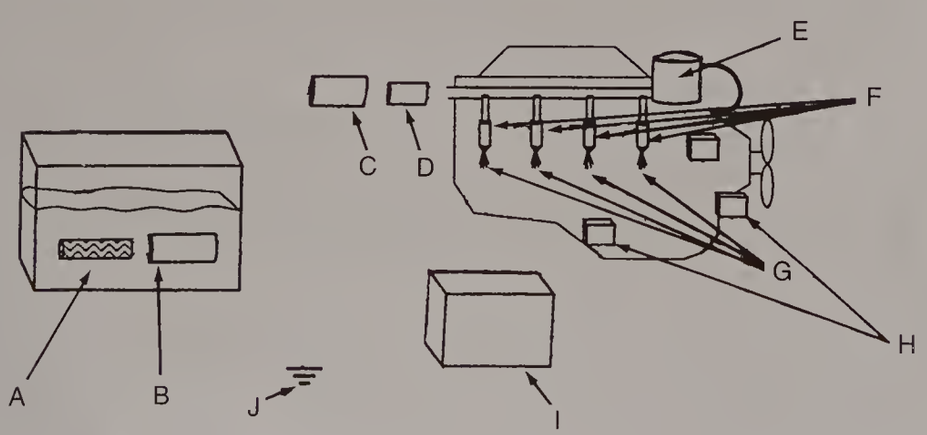
Fuel System Electronics

18. Fuel _____ are actuators that open and close small fuel spray nozzles into the engine intake manifold.

18. _____

19. Draw in the wiring and fuel lines of the fuel system. Then identify the parts indicated on the diagram below.

19. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____



Name _____

Lighting System

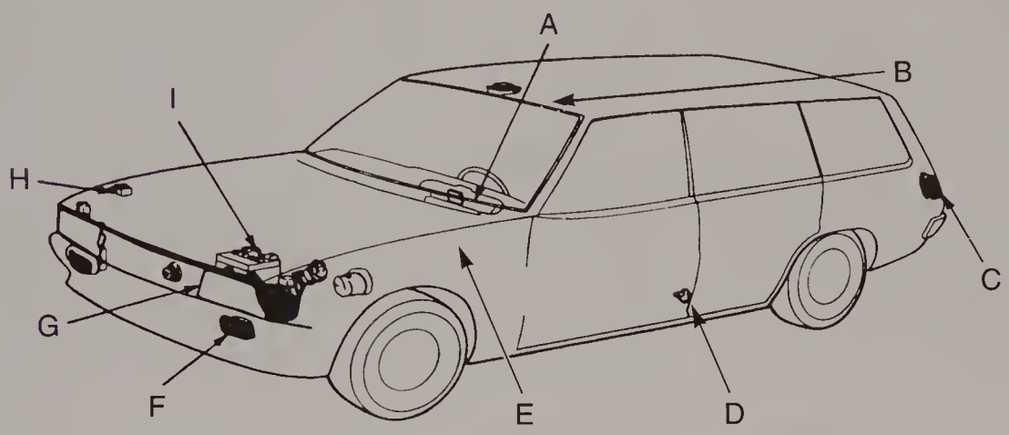
20. Name three examples of how electronics are used in an automotive lighting system.

_____

_____

_____

21. Draw in the wiring of the lighting system. Then identify the parts indicated on the diagram below.



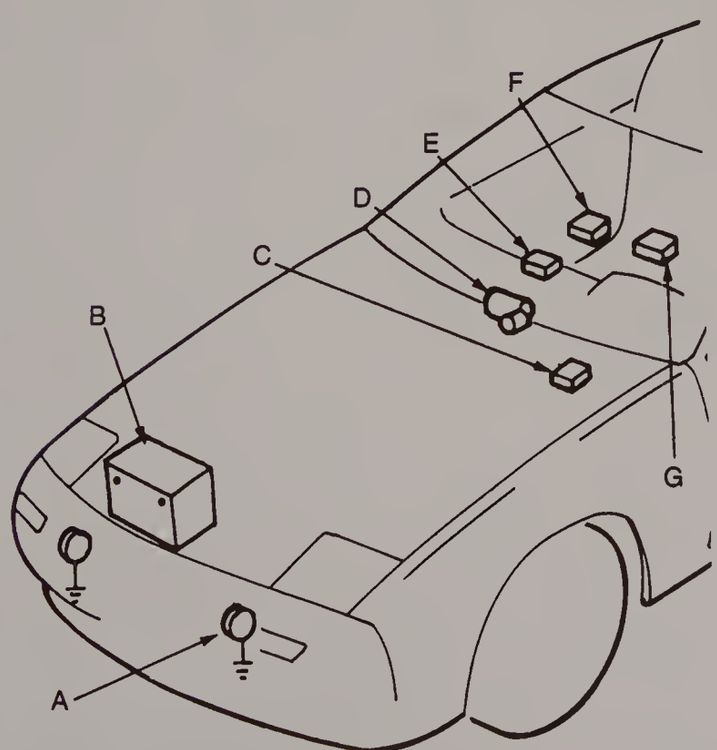
21. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____

Wiper-Washer and Horn Systems

22. The wiper-washer system is primarily _____ (electrical, electronic).

22. _____

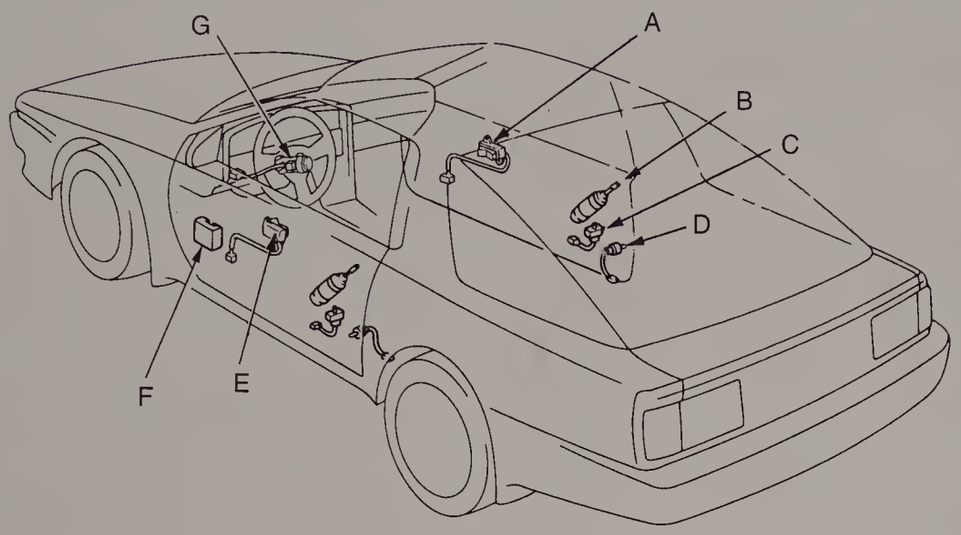
23. Draw in the wiring of the horn and wiper system. Then identify the parts indicated on the diagram below.



23. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

Power Locks, Seats, and Windows

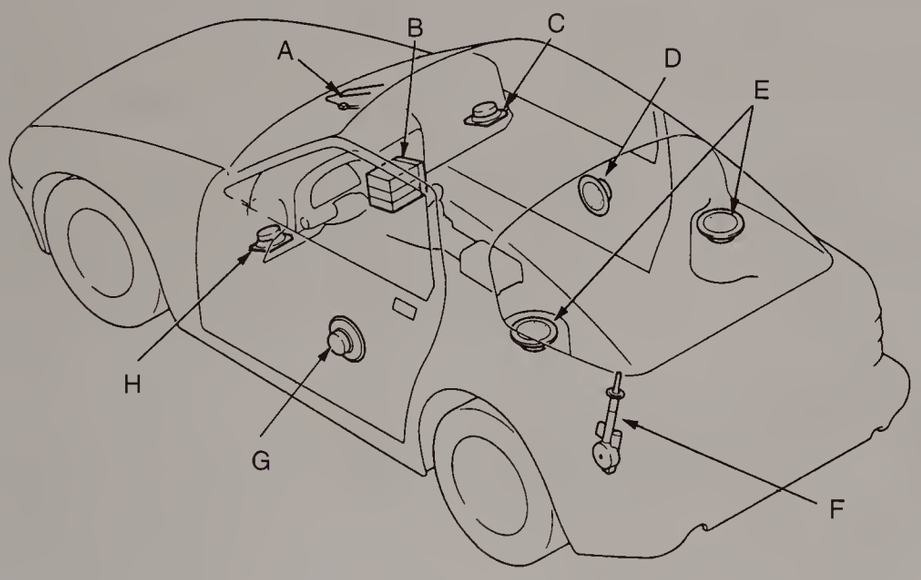
24. Draw in the wiring of the power door locks and power windows. Then identify the parts indicated on the diagram below.



24. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

Sound Systems

25. Draw the wiring of the sound system. Then identify the parts indicated on the diagram below.



25. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

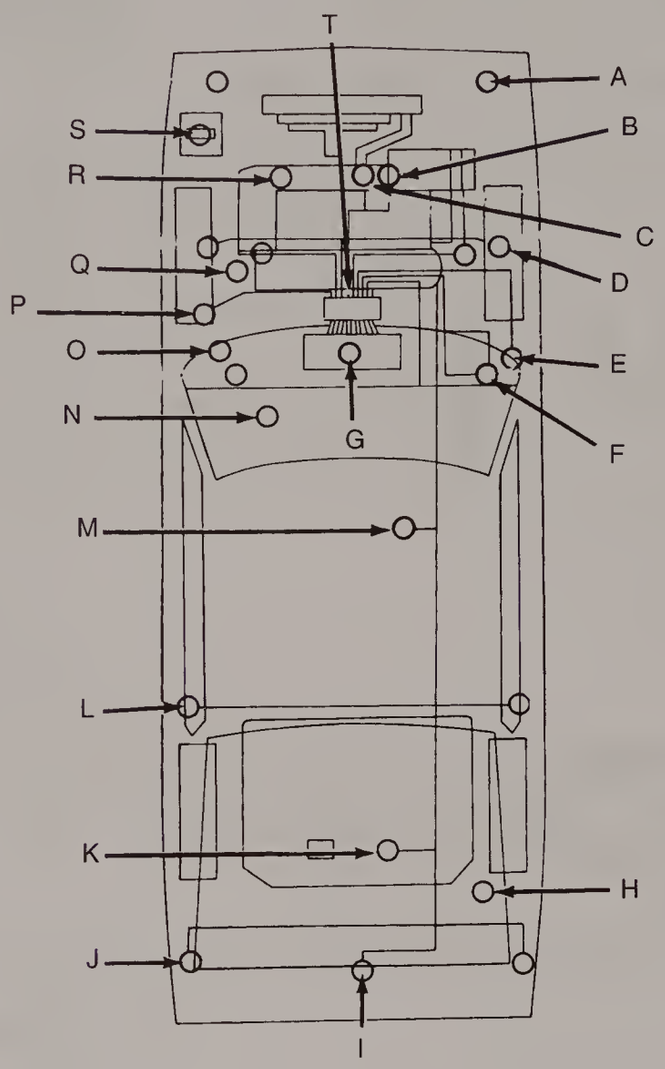
Name _____

Voice Alert Systems

26. How does a voice alert system inform the driver of vehicle conditions?

_____

27. Identify the various sensors used in voice alert systems.



(A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

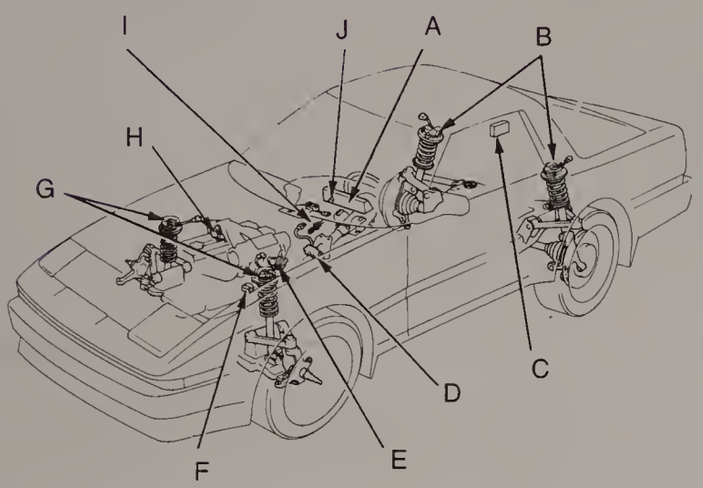
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____

Suspension System Electronics

28. Identify what an automatic damping system uses to control shock stiffness.

28. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____

29. Identify the parts indicated on the diagram of the suspension system below.



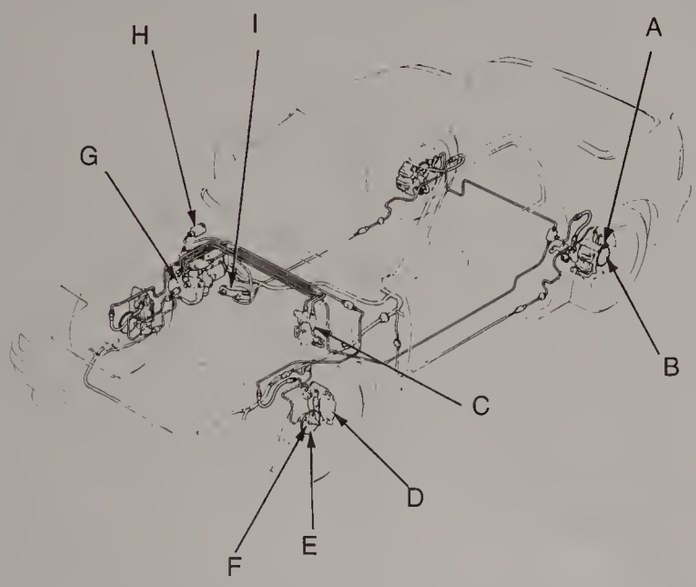
29. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

Brake System Electronics

30. A(n) _____ brake system uses wheel speed sensors, a hydraulic actuator, and a computer to maintain directional stability and steerability during braking.

30. _____

31. Identify the parts indicated on the diagram below.



31. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____

Name _____

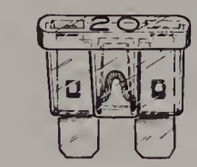
Date _____

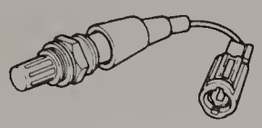
Instructor _____

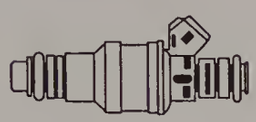
Score _____ Text pages 19–28

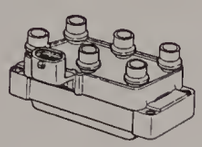
Chapter 2

Electrical Principles









After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the structure of the atom and how it relates to electricity.
- Describe the action of a magnetic field.
- Summarize how an electric current will produce magnetism.
- Define the laws of opposite and like charges.
- Explain how a magnetic field can be used to produce electricity.
- Describe the components of a simple electric circuit.
- Compare Conventional and Electron Theories of current flow.
- Define the term "voltage."
- Define the term "current."
- Define the term "resistance."
- Compare DC and AC current.
- Compare a simple water circuit with an electric circuit.

Instructions: As you study Chapter 2 of the text, complete the following workbook problems in the spaces provided.

Atomic Structure

- Match the following parts of matter with their descriptions.

(A) A small group of different elements.

(B) A group of one type of atoms.

(C) A group of different molecules.

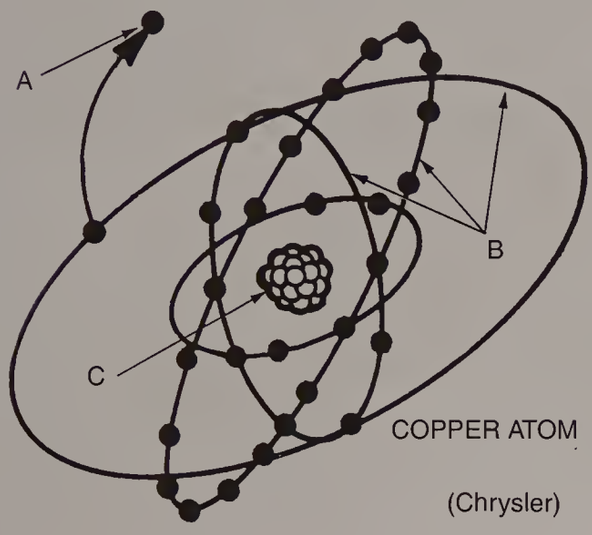
(D) The smallest particle in matter.

1. Atom D
2. Element C
3. Molecule A
4. Compound A

5. List the three basic parts of an atom and indicate whether the charge in each is positive, negative, or neutral.

Protons, Neutrons, and Electrons. Protons are positive
Neutrons are negative

6. Identify the items indicated on the illustration below.



COPPER ATOM

(Chrysler)

6. (A) _____

(B) _____

(C) _____

Electricity

7. Define *electricity.*

A form of energy resulting from the existence of charged particles (such as electrons and protons) as a charge or current.

8. Electrical flow, or discharge, will result if excess electrons produce a _____ charge on one end of a wire and excess protons produce a positive charge on the other end. 8. _____

9. If there is enough potential difference, a(n) _____ can enter the orbit in a new atom. 9. _____

10. A(n) _____ (conductor, insulator) is a substance that allows the flow of free electrons. 10. _____

11. A(n) _____ (conductor, insulator) is a substance that resists or stops electrical flow. 11. _____

Name _____

12. Various materials are listed below. If the material is an insulator, identify it with an *I*. If a material is a conductor, identify it with a *C*.

Plastic I

Porcelain _____

Copper C

Aluminum C

Silver C

Rubber I

Glass I

Iron C

13. List the three basic functions of electricity.

Energy

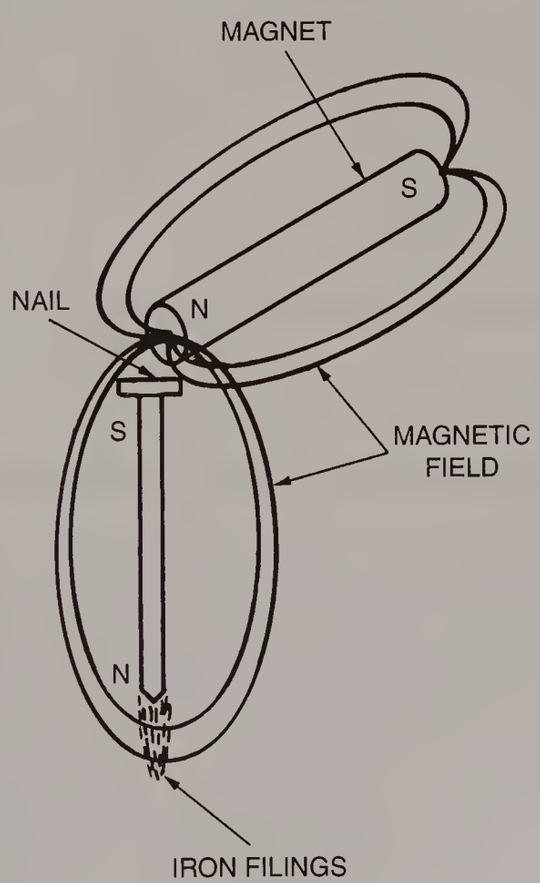
_____

_____

Magnetism

14. Magnetism is a(n) _____ force that can attract or repel through space, air, or solid matter. 14. _____

15. In the diagram below, the magnet activity on the nail shows the effect of magnetic _____. 15. _____



16. A magnetic field has little or no effect on all of the following EXCEPT: 16. _____

    (A) glass.

    (B) iron.

    (C) plastic.

    (D) wood.

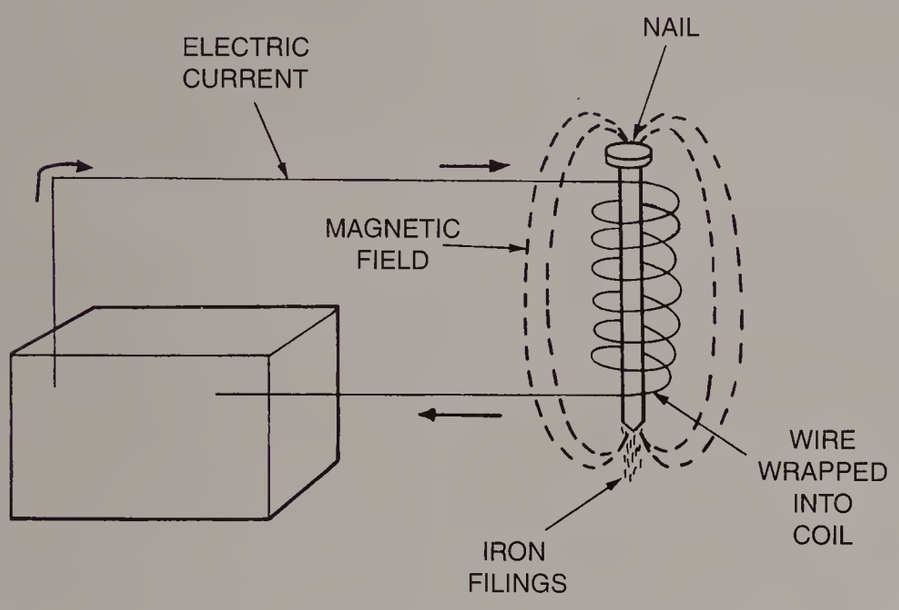
17. Like charges _____ (attract, repel). 17. _____

18. Unlike charges _____ (attract, repel). 18. _____

19. The interaction of electricity and magnetism is a branch of physics called _____. 19. _____

20. In the illustration below, a(n) _____ has been made by wrapping wire around an iron core. 20. _____

21. Current through the wire will produce a _____ (weak, powerful) magnetic field. 21. _____



22. What results when a wire carrying electricity produces an electrical current in another wire? 22. _____

Simple Electric Circuit

23. List and describe the three basic components of a simple electrical circuit. Give an example of each.

_____

_____

_____

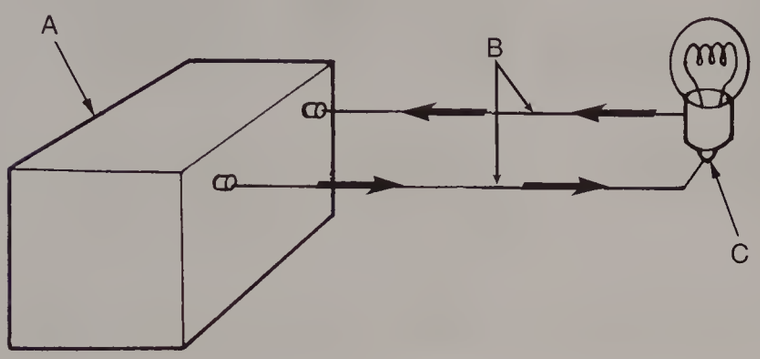
_____

_____

_____

Name _____

24. Identify the basic parts of the illustrated simple or basic electric circuit below.



24. (A) _____
(B) _____
(C) _____

Electrical Values

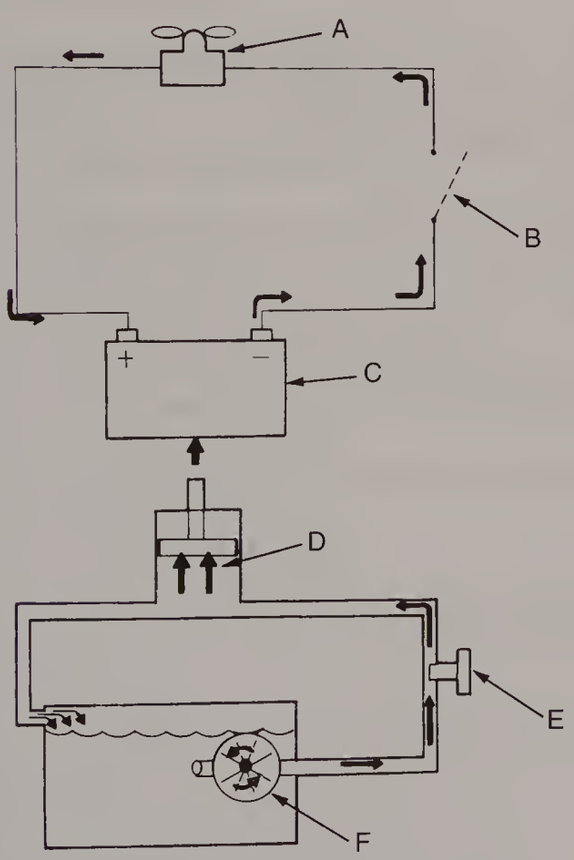
25. List and describe the three fundamental values that refer to the properties of electricity and a simple electrical circuit.

_____

_____

_____

26. Identify the parts indicated on the electrical circuit and hydraulic circuit below.



26. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

27. As voltage increases, current flow tends to _____ . 27. _____

28. _____ current flows in only one direction. 28. _____

29. _____ current flows one direction, reverses, and then flows in the opposite direction. 29. _____

30. _____ _____ is another name for voltage and refers to how voltage has the power or force to cause electron movement through a conductor. 30. _____

31. _____ flow will be high if resistance is low. 31. _____

32. _____ is another name for current. 32. _____

33. _____ is another name for resistance. 33. _____

34. Resistance is designed into all _____ circuits. 34. _____

35. Describe the Conventional Theory.

_____

_____

_____

_____

_____

36. Describe the Electron Theory.

A stable subatomic particle with a charge of negative electricity found in a atoms and acting as primary carrier of electricity and solids

_____

37. _____ (Electron, Conventional) Theory is used in automotive electronics. 37. _____

Name _____

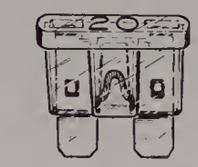
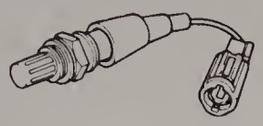
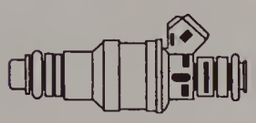
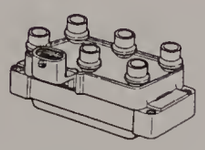
Date _____

Instructor _____

Score _____ Text pages 29–38

Chapter 3

Electrical Circuits, Ohm's Law

After studying this chapter and completing supplemental exercises, you will be able to:

- Draw a series circuit.
- Draw a parallel circuit.
- Draw a series-parallel circuit.
- Explain the operating characteristics of series and parallel circuits.
- Describe a frame ground or one-wire circuit.
- Recall Ohm's Law.
- Summarize the effects of voltage and resistance on current.
- Calculate an unknown circuit value using Ohm's Law.
- List the rules of series and parallel circuits as related to Ohm's Law.
- Recognize typical electrical-electronic symbols.

Instructions: As you study Chapter 3 of the text, complete the following workbook problems in the spaces provided.

Types of Circuits

1. Simple _____ circuits have more than one load connected in a single electrical path. 1. _____

2. Suppose a string of Christmas tree lights was wired in series. If one bulb burned out: 2. _____
   (A) all the other Christmas tree lights would remain on because the current would continue to flow.
   (B) all the other Christmas tree lights would go out because the burned element in the bulb would act as an open switch to stop current flow.
   (C) the bulbs next to it would burn out, but the others would continue to function.
   (D) None of the above.

3. A(n) _____ circuit has more than one path for current flow. 3. _____

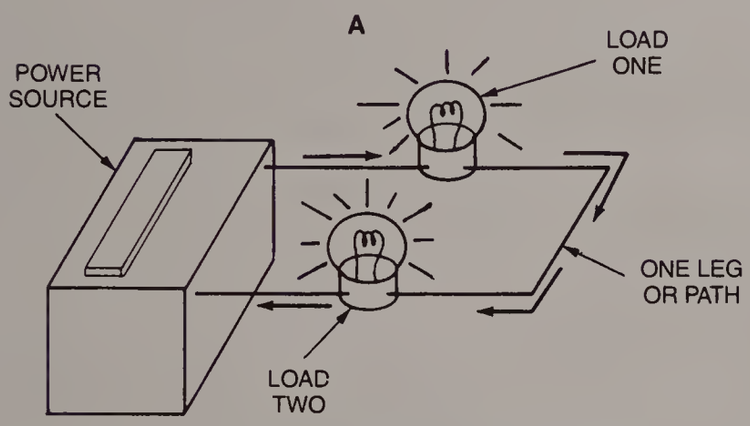
4. Suppose a string of Christmas tree lights was wired in parallel. If one bulb burned out:
   (A) all the other Christmas tree lights would go out because the burned element in the bulb would act as an open switch to stop current flow.
   (B) the bulbs next to it would burn out, but the others would continue to function.
   (C) all the Christmas tree lights, except the burned out bulb, would continue to function because there would still be a complete path around the burned-out bulb.
   (D) None of the above.

4. _____

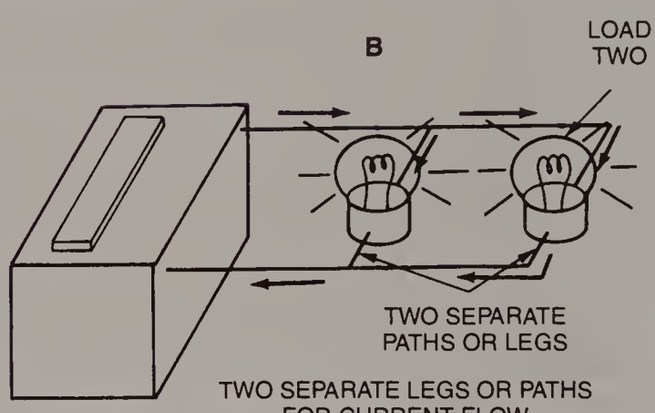
5. Identify the circuits shown below.

5. (A) _____

(B) _____



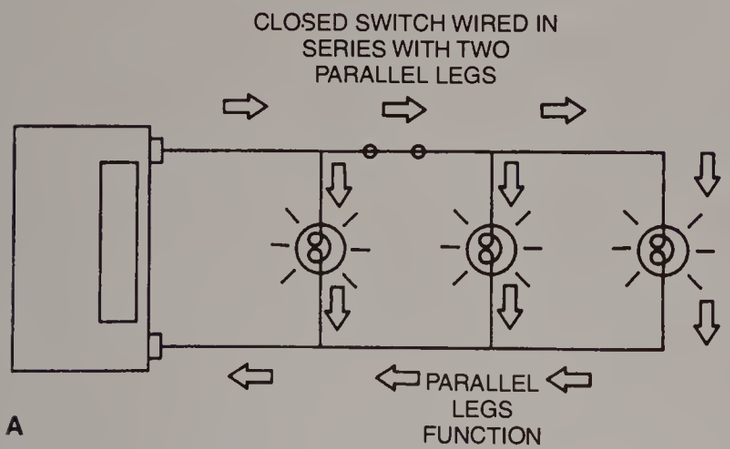
ONE OR MORE LOADS CONNECTED IN ONE ELECTRICAL PATH

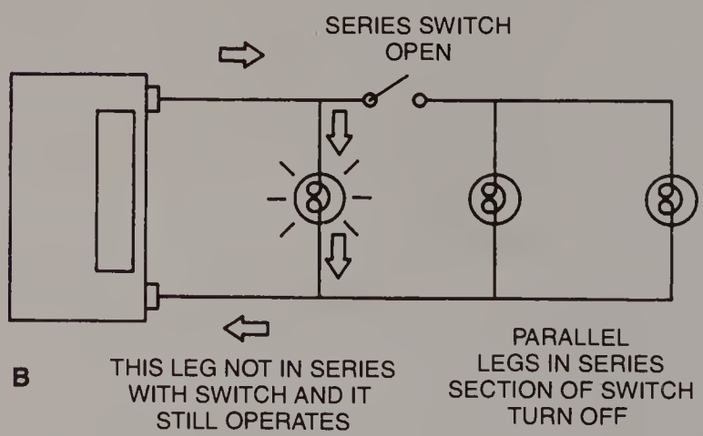


TWO SEPARATE LEGS OR PATHS FOR CURRENT FLOW

6. Identify the type of circuit shown in the diagrams below.

6. _____





_____ _____

_____ _____

Name _____

7. A(n) _____-_____ circuit, also called a one-wire circuit, uses the metal structure of the car to return current to the source (car battery).

7. _____

8. Identify the circuit shown in the illustration below and identify the items indicated.

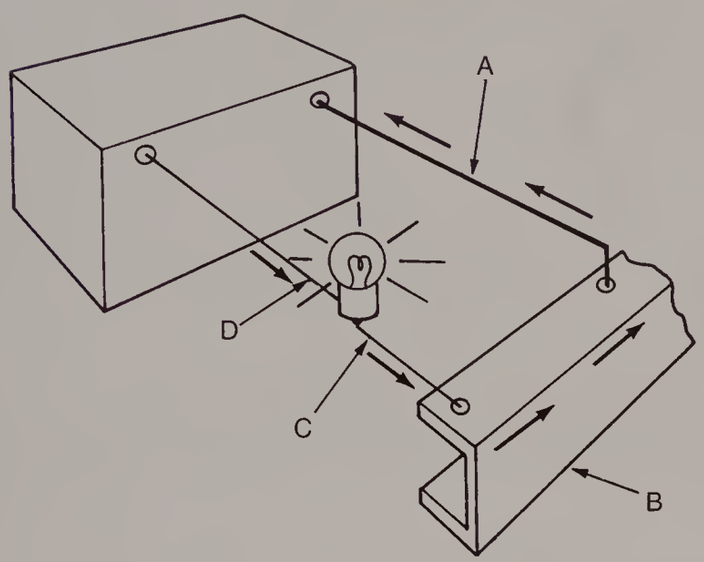
Circuit:_____.

8. (A) _____

(B) _____

(C) _____

(D) _____



9. Which of the following refers to the section of the circuit that carries current to a load or component?
   (A) Hot leg or hot wire.
   (B) Ground leg or ground wire.
   (C) Either hot leg or ground wire.
   (D) None of the above.

9. A

Ohm's Law

10. Ohm's law is a simple formula used to express the relationship between voltage, _____ , and resistance.

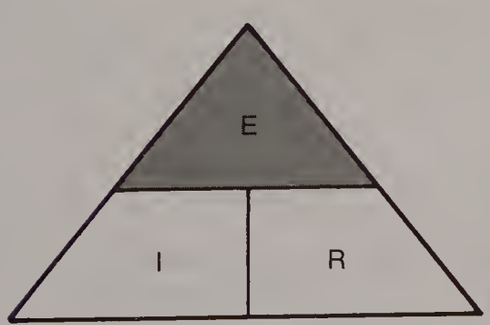
10. Current

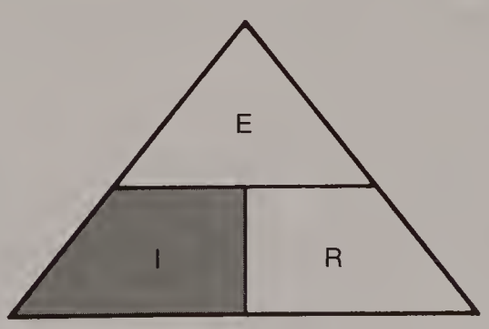
11. Ohm's law states three basic formulas. Look at the triangles below and write the formulas.

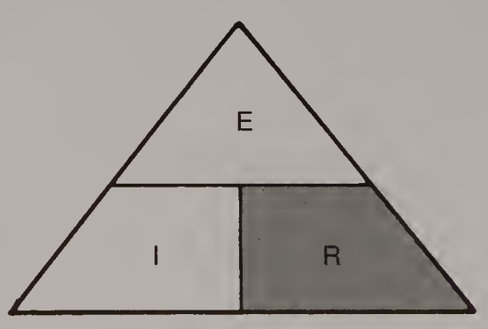
11. (A) $I \times R = E$

(B) $E \div R = I$

(C) $E \div I = R$





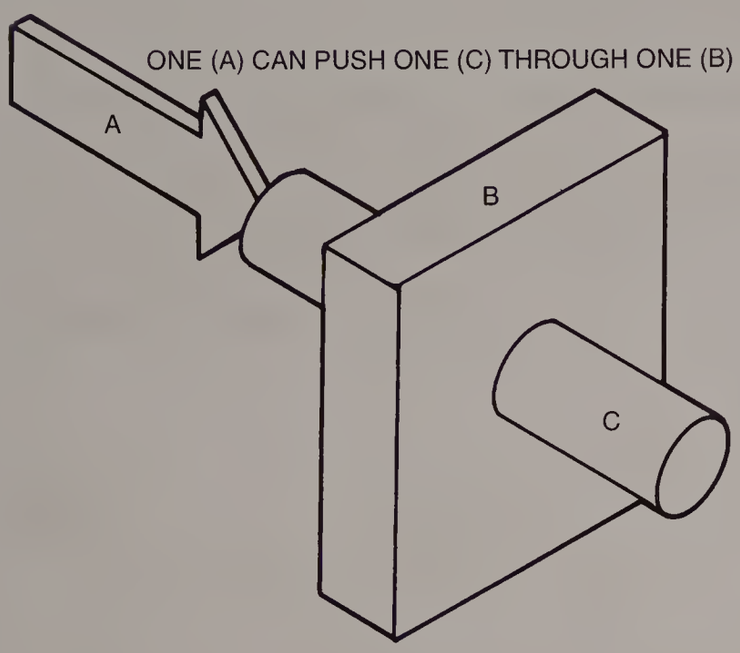


12. Identify the items represented by this diagram.

12. (A) _____

(B) _____

(C) _____

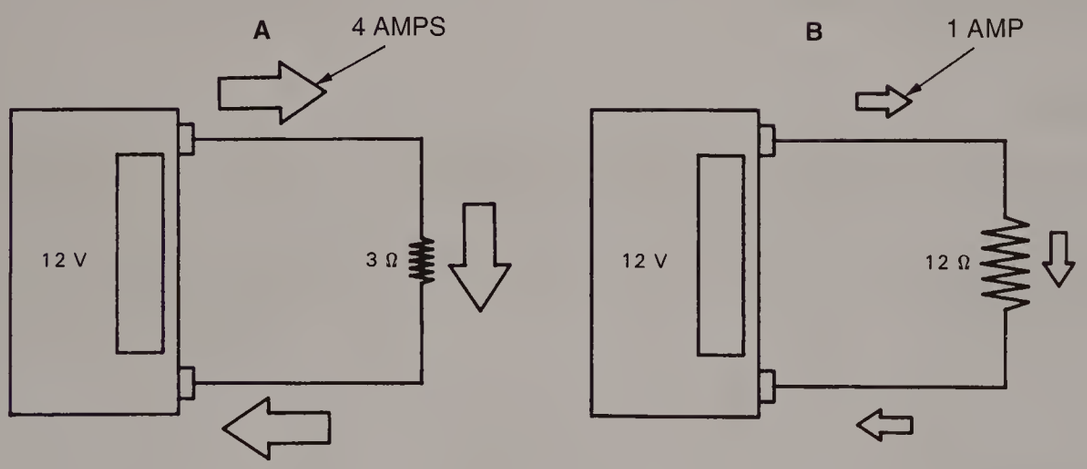


13. In auto electronics, most electrical problems are caused by a change in _____ _____.

13. _____

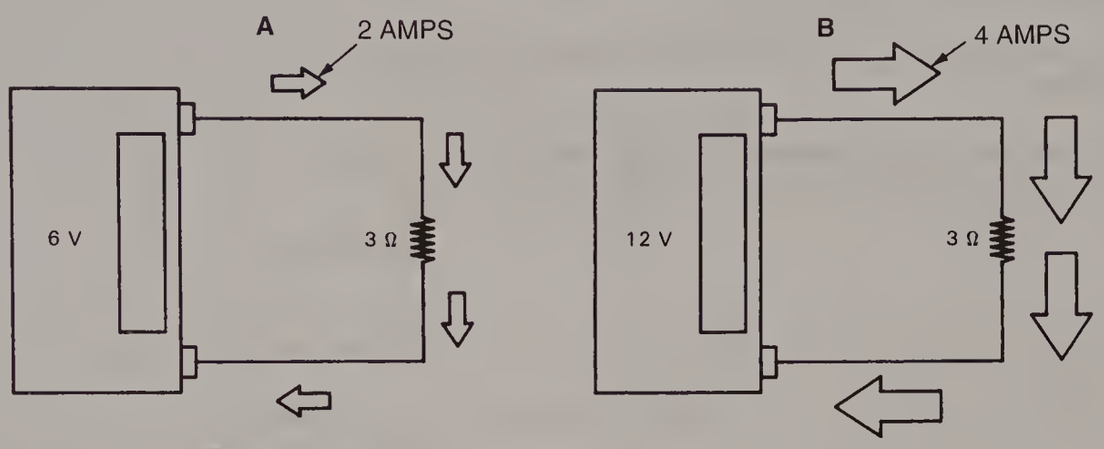
14. Which of the circuits below has less current?

14. _____



Name _____

15. Which of the circuits below has higher current? 15. _____



16. _____ is the same everywhere in a series circuit. 16. _____

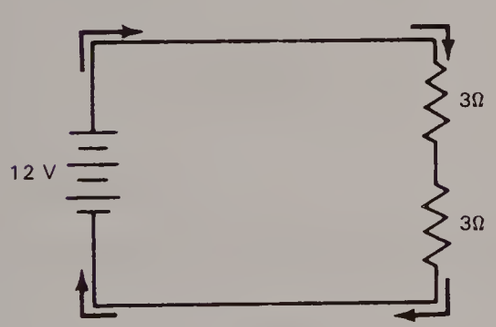
17. What is the formula for total resistance in a series circuit?

_____

_____

18. The sum of the voltage drops across all the resistance elements in a series circuit equals the _____ voltage. 18. _____

19. In the series circuit below, determine current flow. 19. _____



20. In a parallel circuit, if you have three branches carrying two amps each, then the total circuit current would be: 20. _____
(A) 6 amps.
(B) 5 amps.
(C) 1 amp.
(D) None of the above.

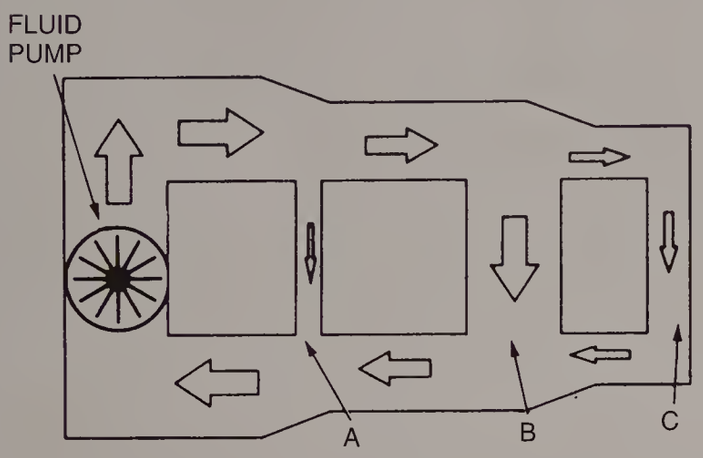
21. In a parallel circuit, total circuit resistance is _____ (less, more) than any one branch. 21. _____

22. In a(n) _____ circuit, voltage applied to each branch is the same. 22. _____

23. Current follows the path of least _____. 23. _____

24. Series circuit operation is _____ (less, more) complex than parallel circuit operation. 24. _____

25. Look at the diagrams below. Indicate whether resistance is low, medium, or high. Also indicate whether current flow is little, medium, or high.



(A) Resistance: _____

Flow: _____

(B) Resistance: _____

Flow: _____

(C) Resistance: _____

Flow: _____

(D) Resistance: _____

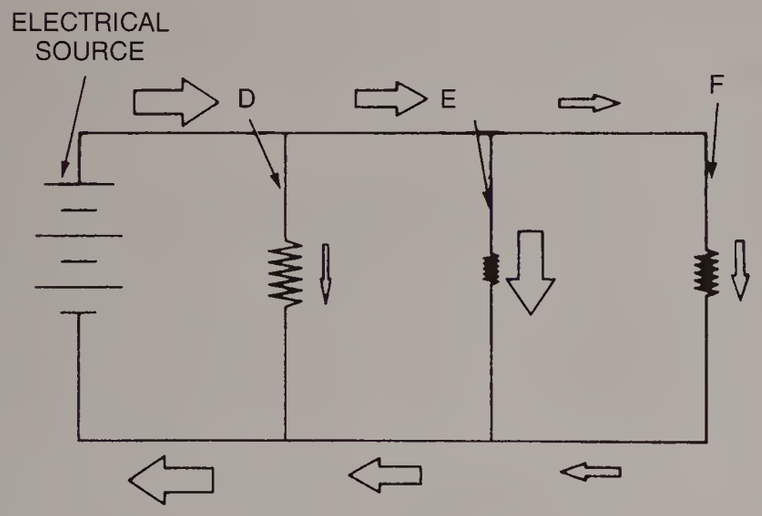
Flow: _____

(E) Resistance: _____

Flow: _____

(F) Resistance: _____

Flow: _____



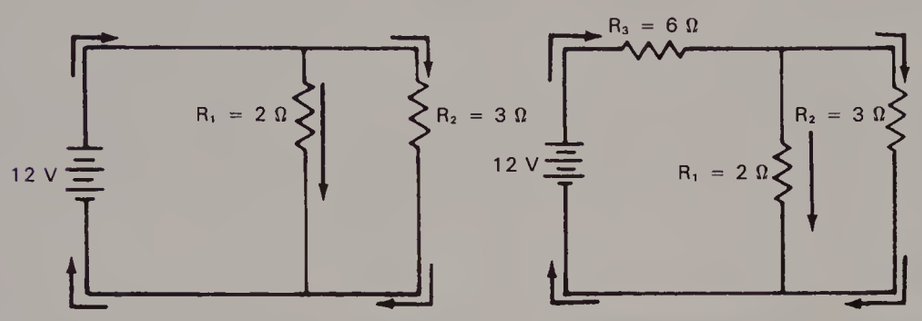
26. What is the formula for finding total resistance in a parallel circuit? 26. _____

Name _____

27. Find the total resistance and amps for the parallel circuit below.
(Use the space provided for calculations.)

Total resistance: _____

Amps: _____

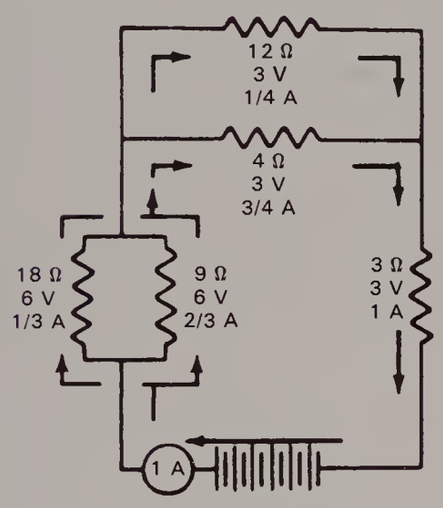


28. Determine the following values for the series parallel circuit below.
(Use the space provided for calculations.)

V_t = _____

R_t = _____

I_t = _____



Prefixes

29. Complete the chart below by filling in the correct prefixes and symbols.

MULTIPLIER	EXPONENT FORM	PREFIX	SYMBOL
1 000 000 000 000	10^{12}		
1 000 000 000	10^{9}		
1 000 000	10^{6}		
1 000	10^{3}		
10	10^{1}		
0.1	10^{-1}		
0.01	10^{-2}		
0.001	10^{-3}		
0.000 001	10^{-6}		
0.000 000 001	10^{-9}		
0.000 000 000 001	10^{-12}		

Electrical Power

30. Electrical power is work done by an electrical current, and its unit of measurement is the _____. 30. _____

31. List two formulas for watts.

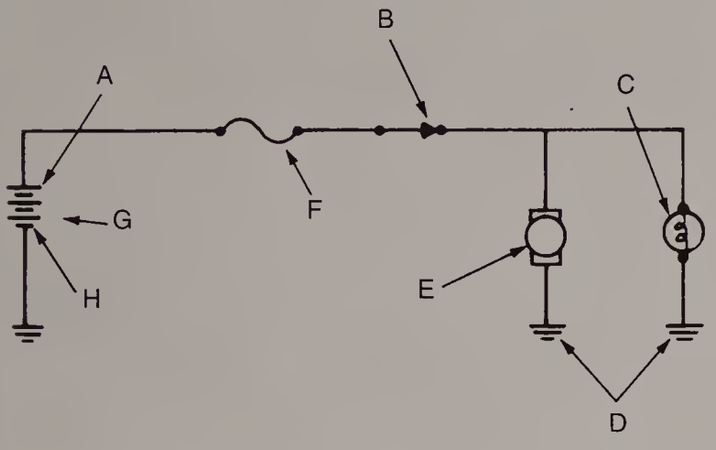
_____ _____

_____ _____

Electrical-Electronic Symbols

32. _____ _____ serve as "electrical road maps" that show how all wires connect to the components in a circuit. 32. _____

33. Identify the items indicated on the diagram below.



33. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

Name _____

34. Identify the purpose of the electrical-electronic symbols shown below.

_____

_____

_____

+	POSITIVE
−	NEGATIVE
	GROUND
	FUSE
	CIRCUIT BREAKER
	CAPACITOR
Ω	OHMS
	RESISTOR
	VARIABLE RESISTOR
	COIL
	STEP UP COIL
	OPEN CONTACT
	CLOSED CONTACT
	CLOSED SWITCH
	OPEN SWITCH
	TWO POLE SINGLE THROW SWITCH
	PRESSURE SWITCH
	SOLENOID SWITCH
	DIODE OR RECTIFIER

	CONNECTOR
	MALE CONNECTOR
	FEMALE CONNECTOR
Y Y Y	MULTIPLE CONNECTOR
	DENOTES WIRE CONTINUES ELSEWHERE
	SPLICE
J2 2	SPLICE IDENTIFICATION
	THERMAL ELEMENT (BI-METAL STRIP)
	"Y" WINDINGS
88:88	DIGITAL READOUT
	SINGLE FILAMENT LAMP
	DUAL FILAMENT LAMP
	L.E.D.-LIGHT EMITTING DIODE
	THERMISTOR
	GAUGE
TIMER	TIMER
	MOTOR
	ARMATURE AND BRUSHES
	DENOTES WIRE GOES THROUGH GROMMET

35. Electrical-electronic symbols and diagrams _____ (can, cannot) vary in different service manuals. 35. _____

Name _____

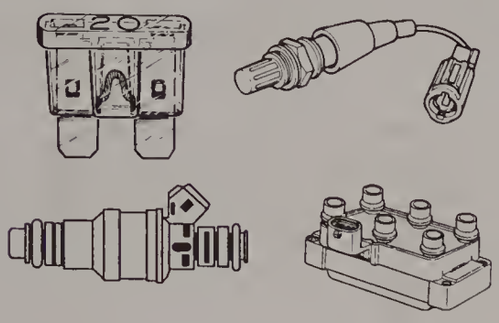
Date _____

Instructor _____

Score _____ Text pages 39–54

Chapter 4

Electrical Components



After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the purpose of fundamental electrical components.
- Draw the symbols for common electrical devices.
- Describe ratings for electrical components.
- Explain how basic electrical components are used in automotive circuits.
- Describe special variations of basic electrical devices.
- More fully comprehend later textbook chapters that refer to the operation of electrical components.

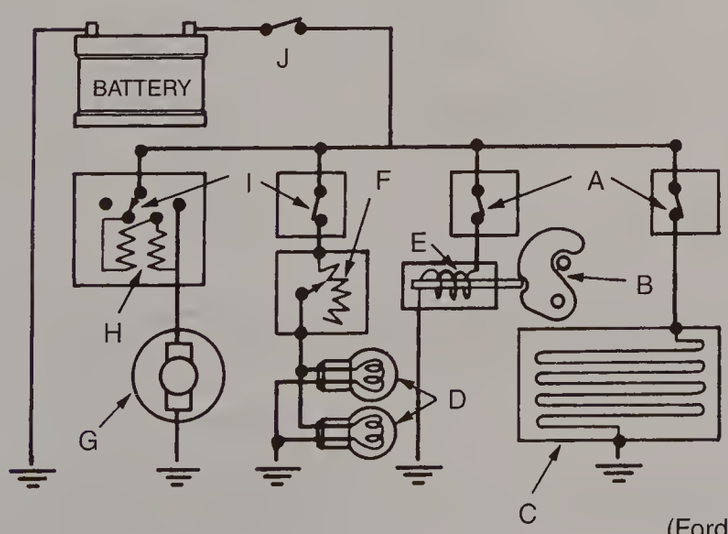
Instructions: As you study Chapter 4 of the text, complete the following workbook problems in the spaces provided.

Resistors

1. Which of the following is an electrical component? 1. _____
   (A) Resistor.
   (B) Transistor.
   (C) Integrated circuit
   (D) None of the above.

2. Which of the following is an electronic or solid state component? 2. _____
   (A) Condenser.
   (B) Relay
   (C) Diode.
   (D) None of the above.

3. Identify the electrical components on the illustration below.

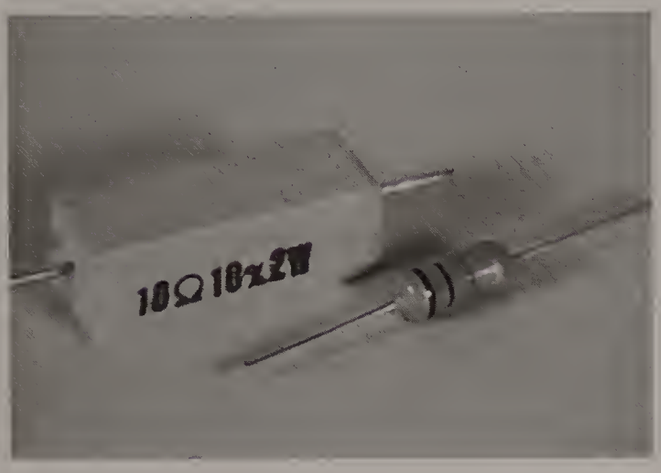


(Ford)

3. (A) _____
   (B) _____
   (C) _____
   (D) _____
   (E) _____
   (F) _____
   (G) _____
   (H) _____
   (I) _____
   (J) _____

4. A(n) _____ limits current flow or utilizes the electric current in a circuit. 4. _____

5. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

6. Some larger, fixed resistors have a color code to denote the: 6. _____
   (A) watt rating.
   (B) resistor tolerance.
   (C) ohms or resistance value.
   (D) All of the above.

7. When replacing a resistor, the watt rating must be the same or _____ (higher, lower) to prevent the resistor from overheating or burning up in service. 7. _____

8. A(n) _____ _____ is a percent value representing how much the ohms value of a resistor can vary above or below the stated specification. 8. _____

9. A(n) _____ resistor alters its own internal resistance as current flow changes. 9. _____

10. A(n) _____ resistor is designed to have two or more ohms values available by connecting different taps or locations on the resistor. 10. _____

11. Identify the item below. Give its symbol, letter designation, and describe its purpose.

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

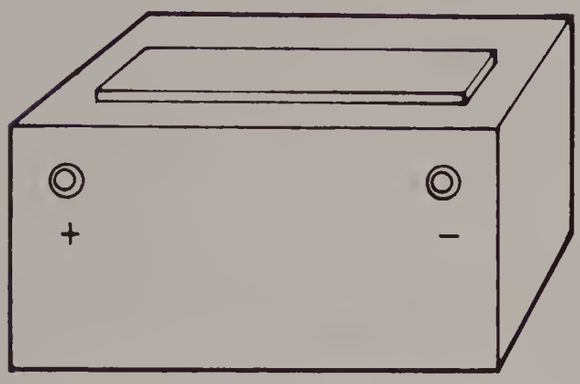
12. A(n) _____ is a variable resistor with two electrical connections for its circuit. 12. _____

13. A(n) _____ is a variable resistor with three electrical connections that allow for more complex use of the variable resistance. 13. _____

Name _____

Batteries

14. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

Switches

15. Identify the various switches represented by the symbols below.

15. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

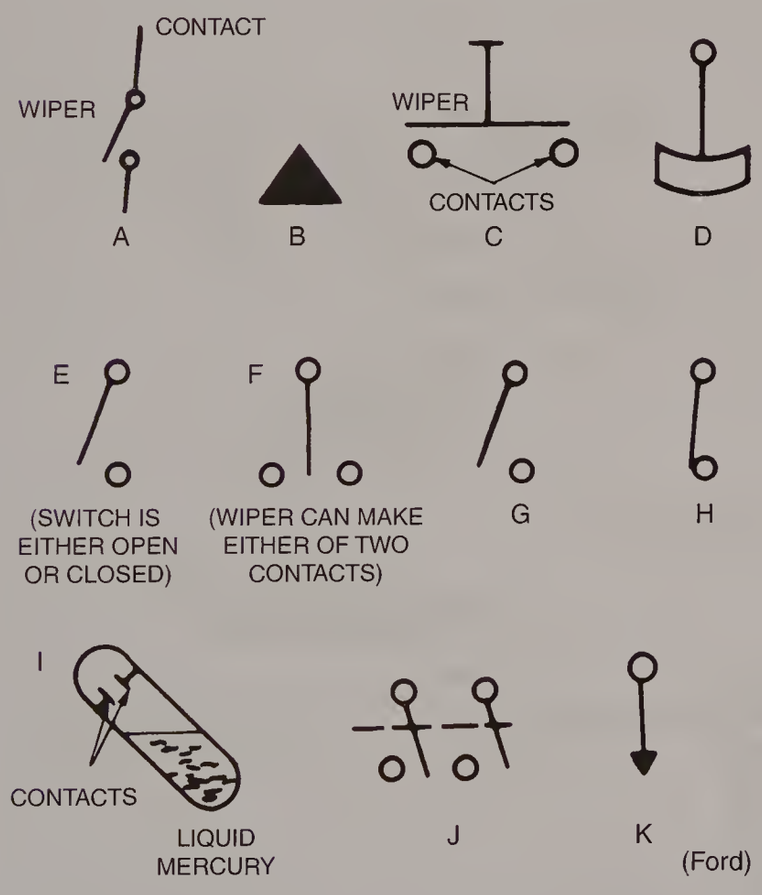
(G) _____

(H) _____

(I) _____

(J) _____

(K) _____

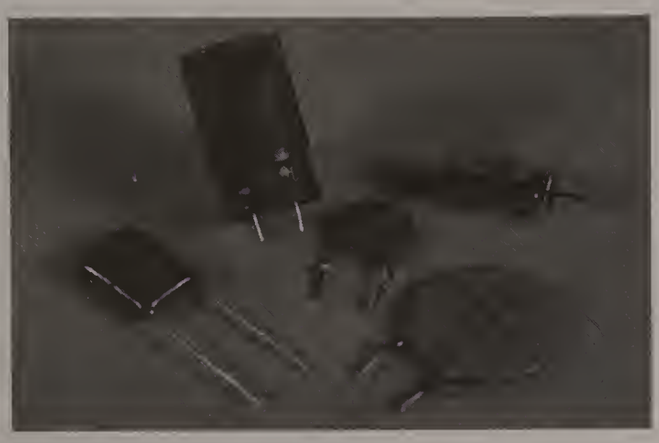


16. Which of the following types of switches has a spring-loaded button that, when pressed, makes or breaks an electrical connection across two contacts?
(A) Toggle switch.
(B) Push-button switch.
(C) Thermal switch.
(D) Pressure switch.

16. _____

Capacitors

17. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

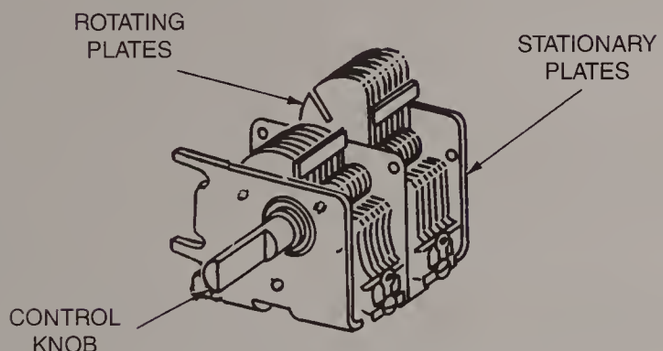
Purpose: _____

_____

_____

_____

18. Identify the item below. Give its symbol, letter designation, and describe its purpose.



(Kelvin Electronics)

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

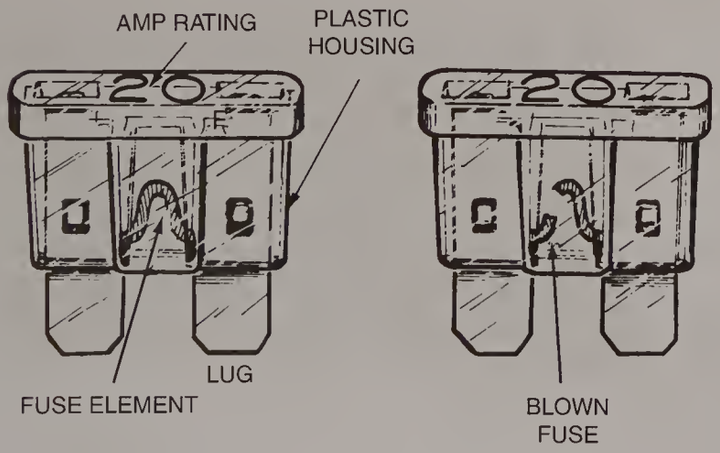
_____

_____

_____

Fuses

19. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

Name _____

20. List three basic types of fuses.

_____

_____

_____

21. A fuse rating is given in: 21. _____
    (A) amps.
    (B) volts.
    (C) ohms.
    (D) None of the above.

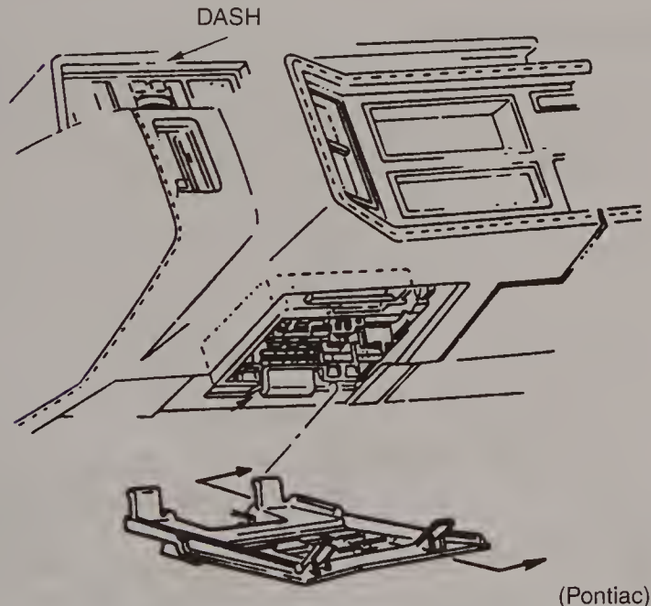
22. When replacing a fuse, why should you always install a fuse with the same amp rating?

_____

23. What is indicated in the drawing below?

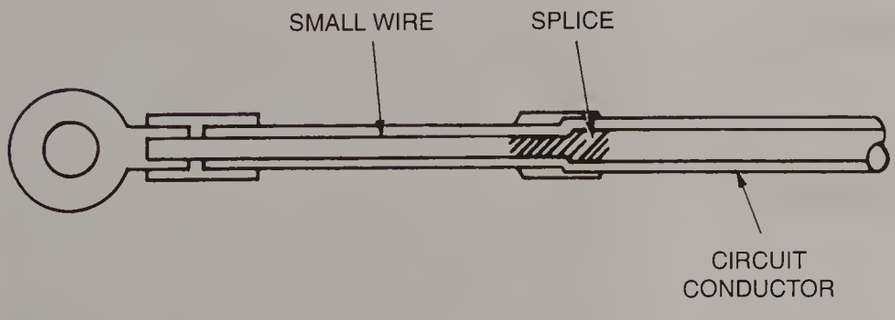
_____

_____



(Pontiac)

24. Identify the item below. Give its symbol, letter designation, and describe its purpose.



(Ford)

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

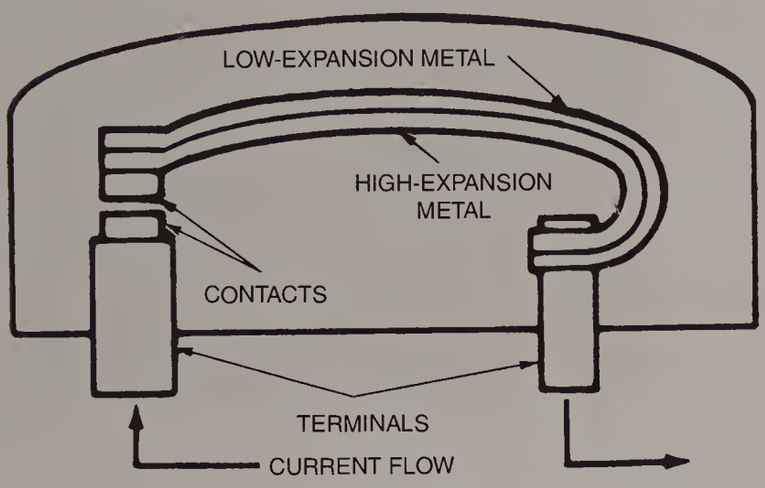
_____

_____

_____

Circuit Breakers

25. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

26. To avoid an electrical _____ , install circuit breakers with the same current rating. 26. _____

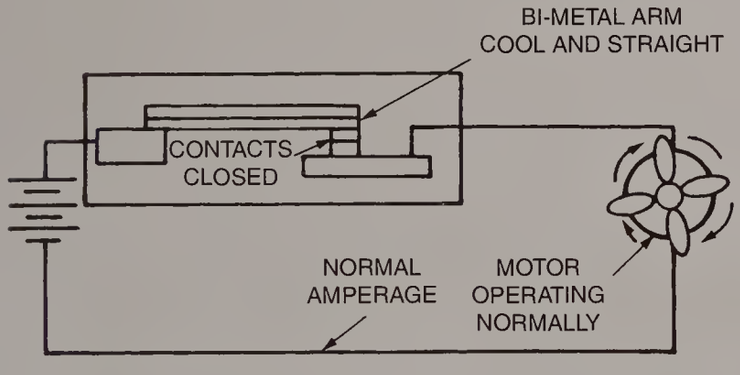
27. Describe what is happening in the diagrams of circuit breaker action below.

(A) _____

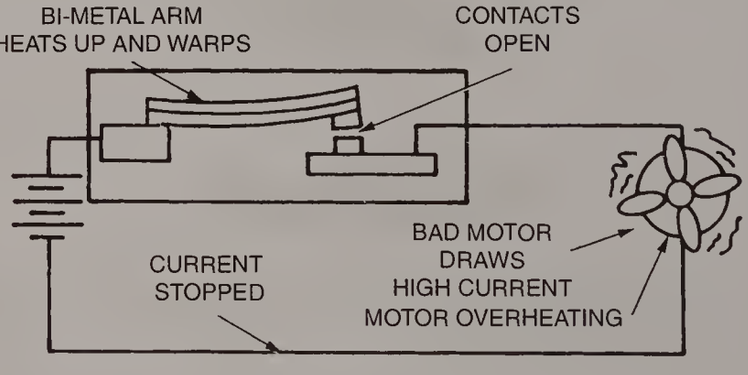
_____

(B) _____

_____



A



B

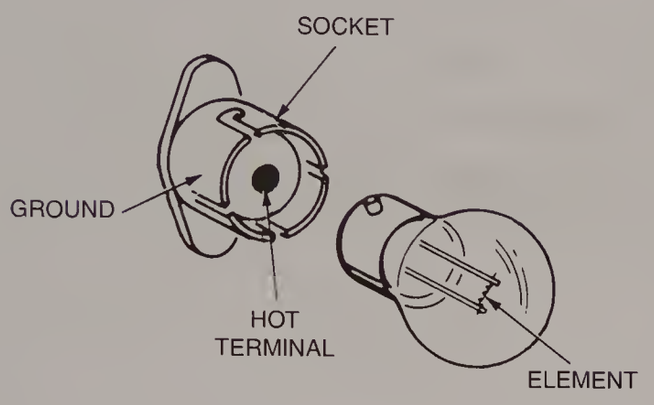
Flashers

28. A(n) _____ is similar to a circuit breaker, but it is designed to open and close the circuit at a constant rate. 28. _____

Name _____

Light Bulbs

29. Identify the item below. Give its symbol, letter designation, and describe its purpose.



(Fiat)

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

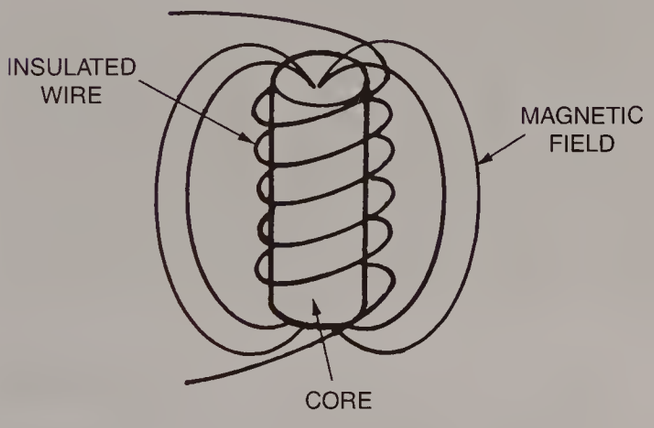
_____

_____

_____

Coils

30. Identify the item below. Give its symbols and describe its purpose.



Item: _____

Symbols: _____

_____

Purpose: _____

_____

_____

_____

Transformers

31. Identify the item below. Give its symbol, letter designation, and describe its purpose.

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

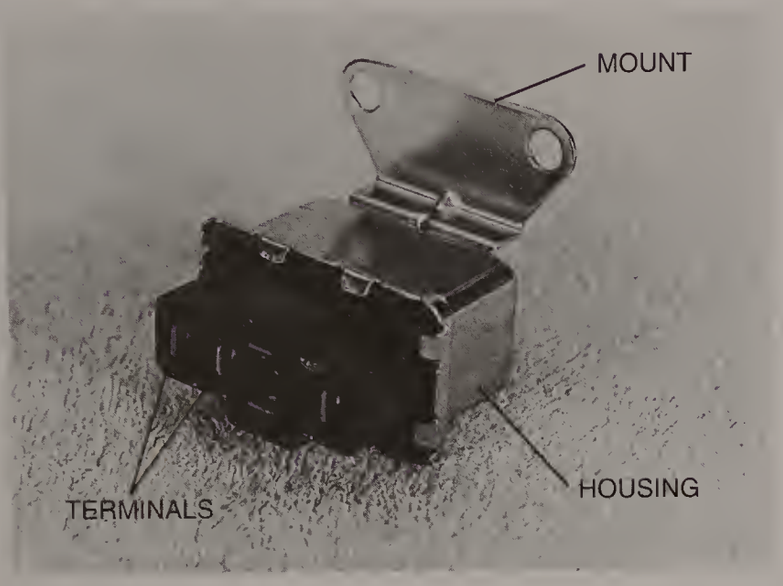
_____

_____

_____

Relays

32. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

_____

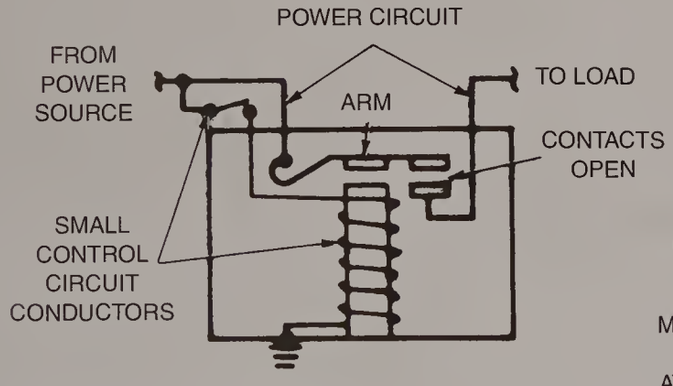
33. Describe what is happening in the diagrams of relay action below.

(A) _____

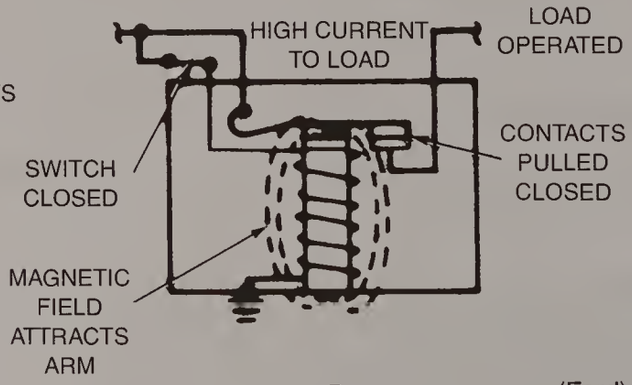
_____

(B) _____

_____



A

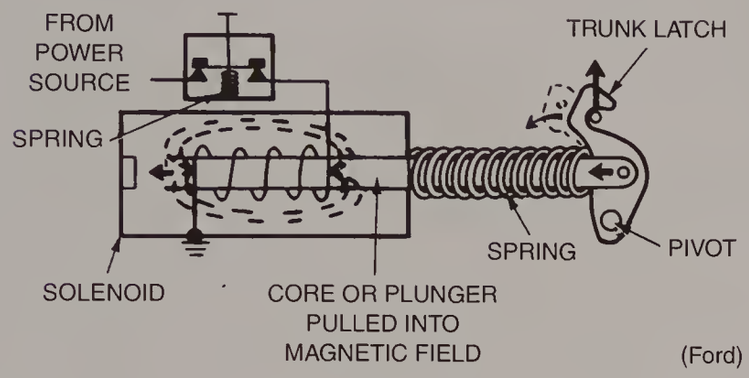


B (Ford)

Name _____

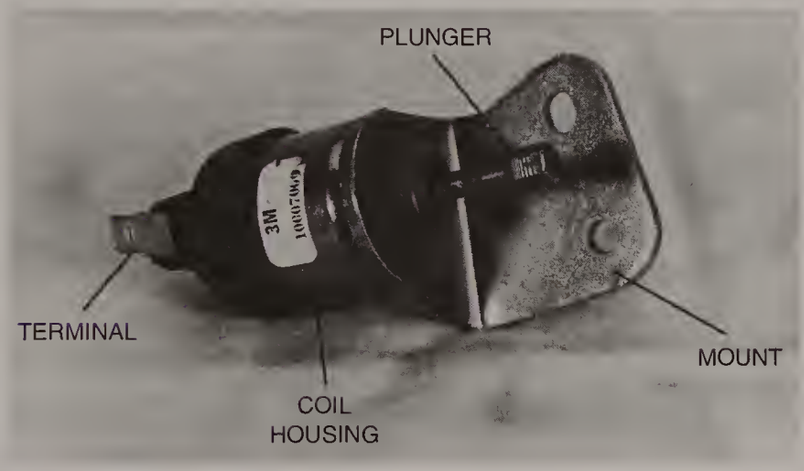
Solenoids

34. The illustration below is an example of how a(n) _____ can convert electrical energy into motion or work. 34. _____



(Ford)

35. Identify the item below. Give its symbol, letter designation, and describe its purpose.



Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

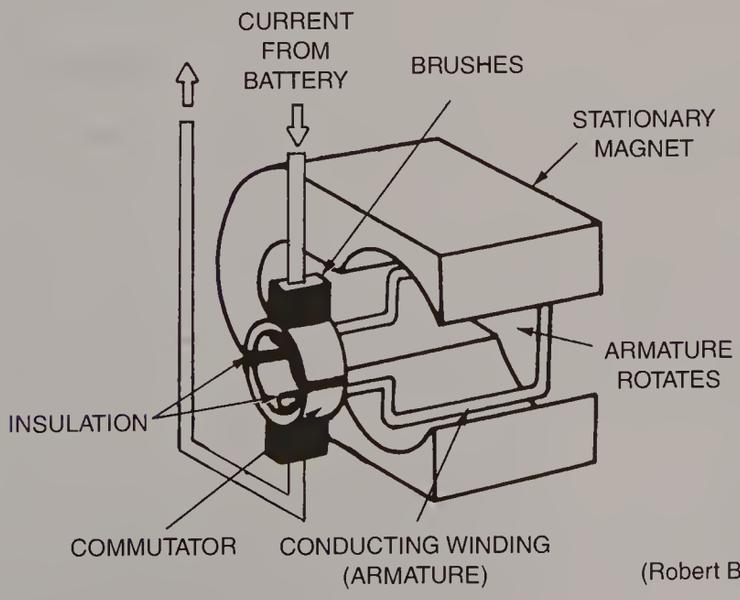
_____

_____

_____

Motors

36. Identify the item below. Give its symbol, letter designation, and describe its purpose.



(Robert Bosch)

Item: _____

Symbol: _____

Letter designation: _____

Purpose: _____

_____

_____

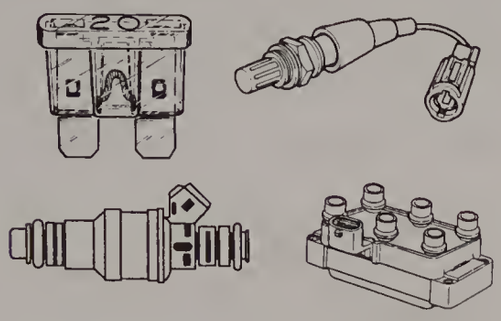
_____

Name _____

Date _____

Instructor _____

Score _____ Text pages 55–72



Chapter 5

Electronic Principles, Components, Digital Logic

After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the operation of semiconductor materials.
- Describe the action of common electronic components.
- Compare variations of electronic components.
- Summarize the operation of photonic devices.
- Explain pulses, waves, signals, and noise.
- Describe basic logic devices.
- Briefly explain the binary numbering system.
- Detail the construction and operation of integrated circuits.

Instructions: As you study Chapter 5 of the text, complete the following workbook problems in the spaces provided.

Semiconductors

1. The terms electronic or _____ _____ refer to components that do not use moving parts. 1. _____

2. A(n) _____ is a crystal material that can act as a conductor or an insulator. 2. _____

3. A P-type semiconductor is a more _____ (positive, negative) substance. 3. _____

4. A N-type semiconductor is a more _____ (positive, negative) substance. 4. _____

Diodes

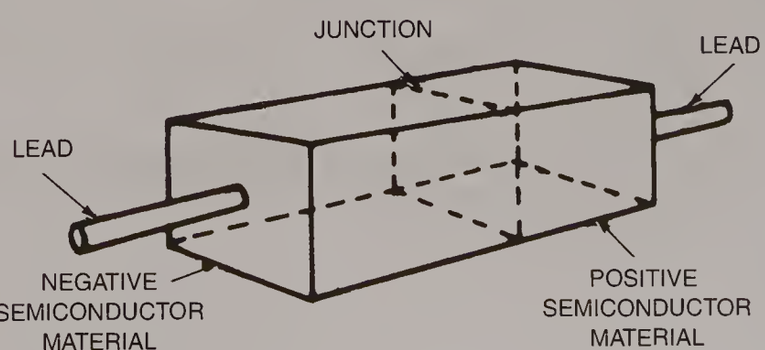
5. Identify the item shown below and describe its purpose.

_____

_____

_____

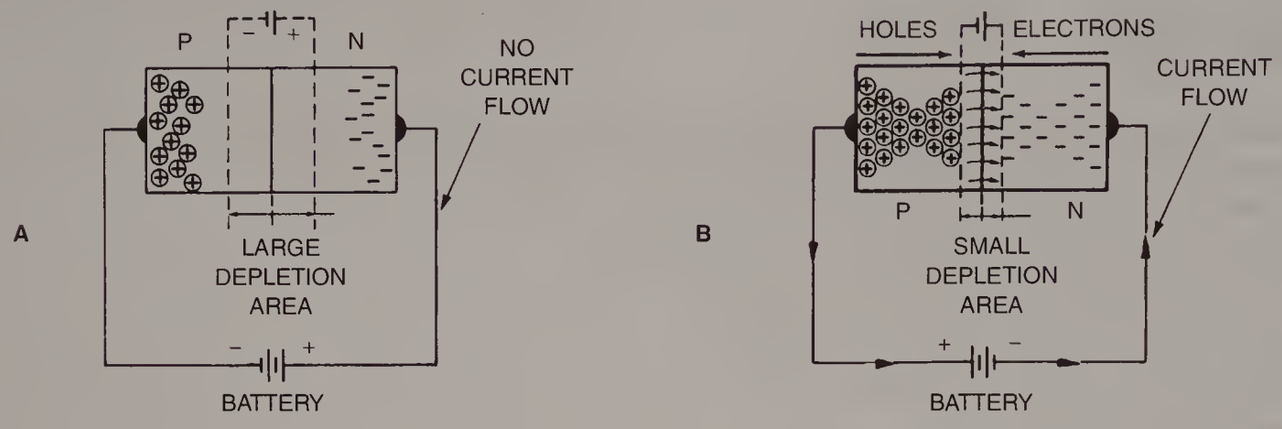
_____



6. Look at the illustrations below. Indicate which one is a forward biased diode and which is a reverse biased diode.

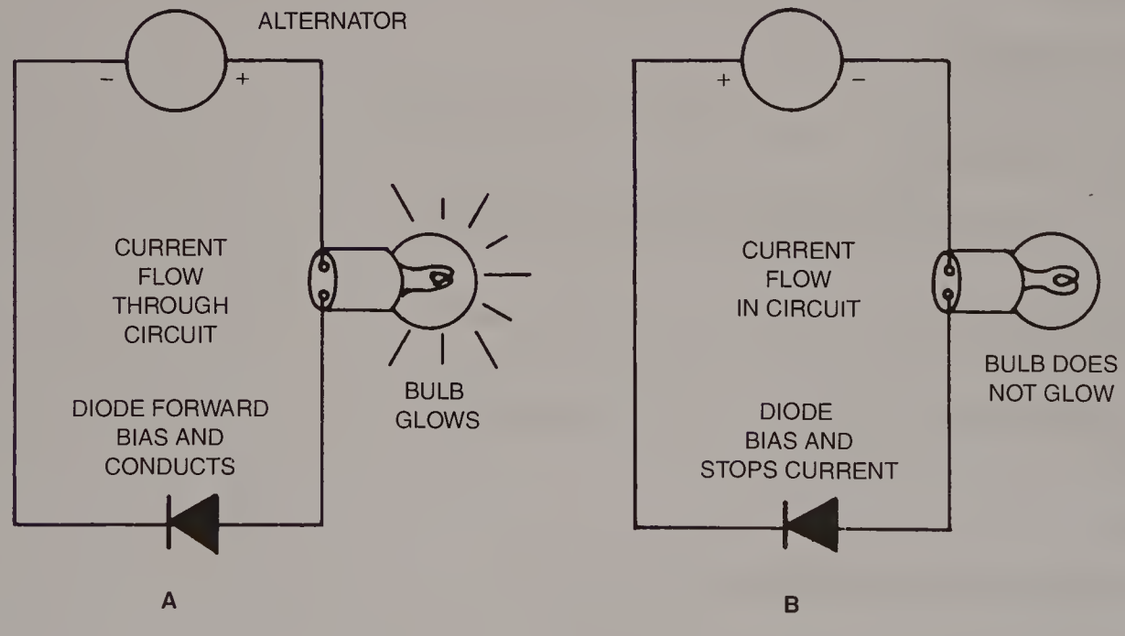
(A) _____

(B) _____



7. _____ refers to changing AC into DC. 7. _____

8. In the diagrams below, use arrows to indicate current flow.



9. The AC must be rectified into _____ for use in an automobile's electrical system. 9. _____

10. A(n) _____ diode is a special diode that serves as a voltage (pressure) relief valve. 10. _____

Name _____

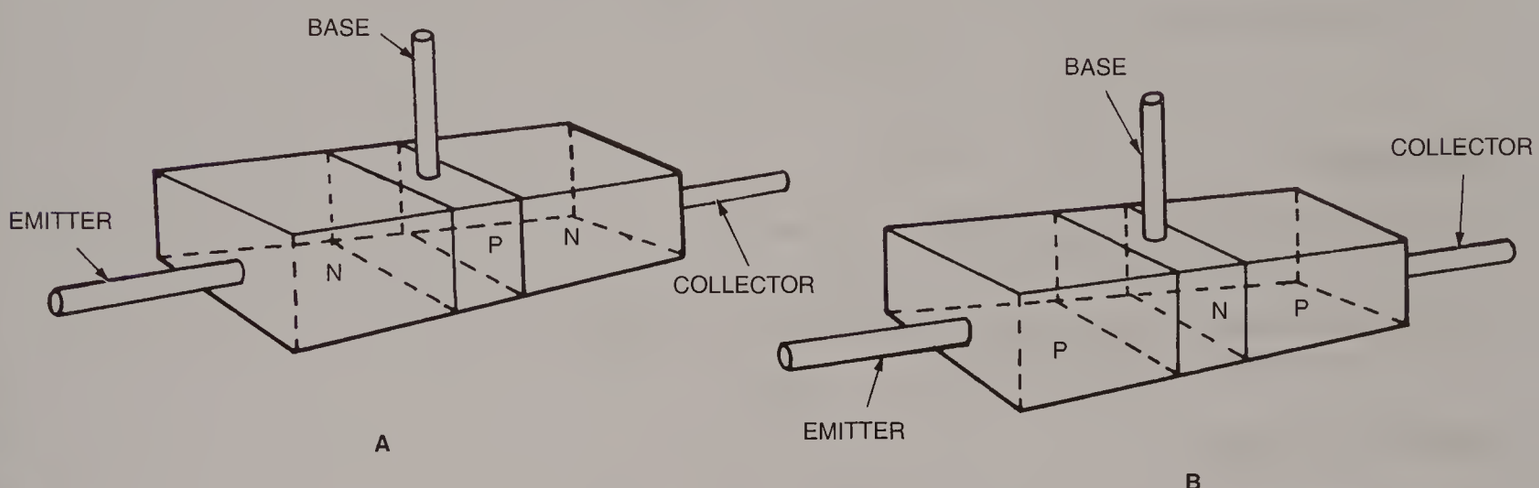
Transistors

11. A transistor is a(n) _____ device for switching or amplifying current in a circuit. 11. _____

12. Identify the types of transistors shown in the diagrams below.

(A) _____

(B) _____



13. Explain what is happening in the illustrations below.

(A) _____

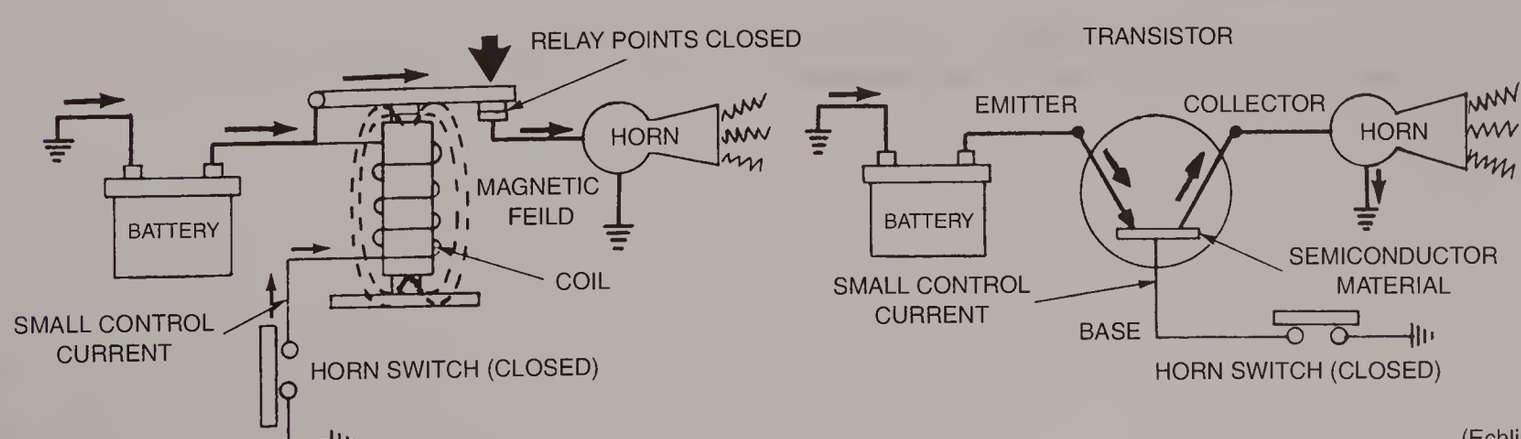
_____

_____

(B) _____

_____

_____



(Echlin)

14. Describe the four types of transistors listed below.

(A) *Signal transistor:* _____

_____

(B) *Power transistor:* _____

_____

(C) *High frequency transistors:* _____

_____

(D) *Field effect transistor:* _____

_____

Thyristors

15. A thyristor is a controllable diode that can only be used as a(n) _____ since it is either on or off. 15. _____

16. A silicon controlled rectifier works like a transistor switch, but cannot amplify _____ . 16. _____

Hall-Effect Chip

17. A Hall-effect chip is a semiconductor device that can produce a small signal voltage or current when acted upon by a(n) _____ _____. 17. _____

18. A(n) _____ crystal uses physical pressure to produce a small current output. 18. _____

Photonic Semiconductors

19. Photonic semiconductor is a classification of devices that can emit or detect _____. 19. _____

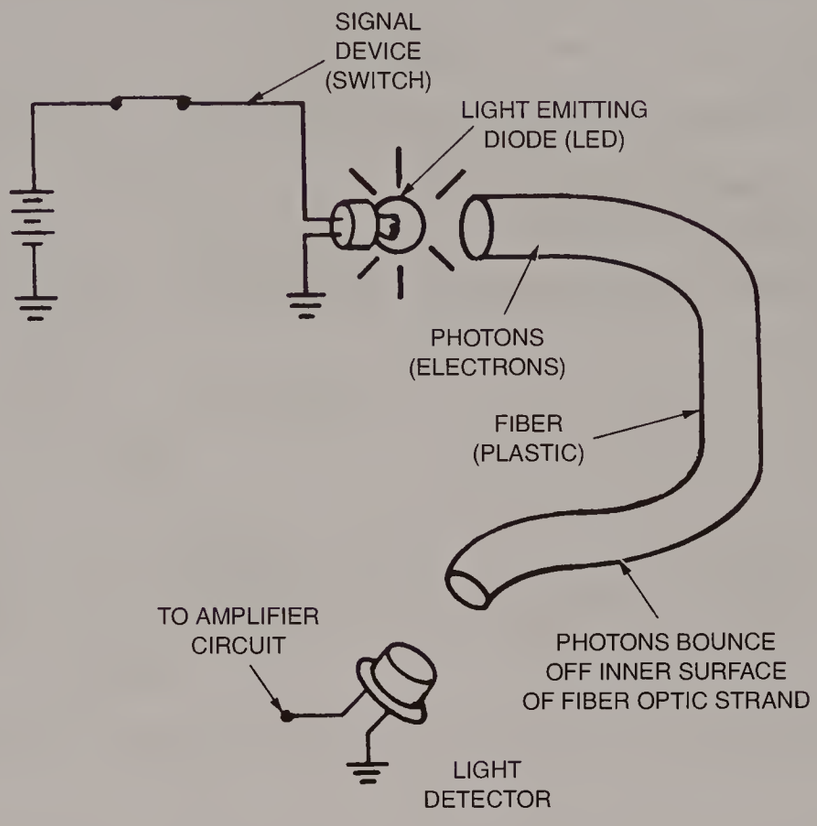
20. A(n) _____ _____ _____ is a semiconductor that will emit light when electrically energized. 20. _____

21. A(n) _____ is a semiconductor that acts as a resistor when in the dark, but changes to a conductor when exposed to light. 21. _____

22. _____ _____ is a field of electronics that uses light flowing through small strands of plastic or glass to send electrical information. 22. _____

Name _____

23. On the diagram below, use arrows and lines to indicate the flow of flashing light through a strand of fiber optic material.



24. A(n) _____ _____ is a photonic device that will convert light directly into DC electricity. 24. _____

25. A(n) _____ will become a small source of current when excited by light, and it can also be used to control current. 25. _____

26. A(n) _____ might be used in an automatic headlight dimming system. 26. _____

27. A(n) _____ _____ _____ uses a fluid crystal material sandwiched between two sealed glass plates. 27. _____

28. A(n) _____ _____ _____ generates light images by shooting electrons onto a phosphor material. 28. _____

Pulses, Waves, Signals, Noise

- *Items 29 through 32.* Match the following terms with their descriptions.

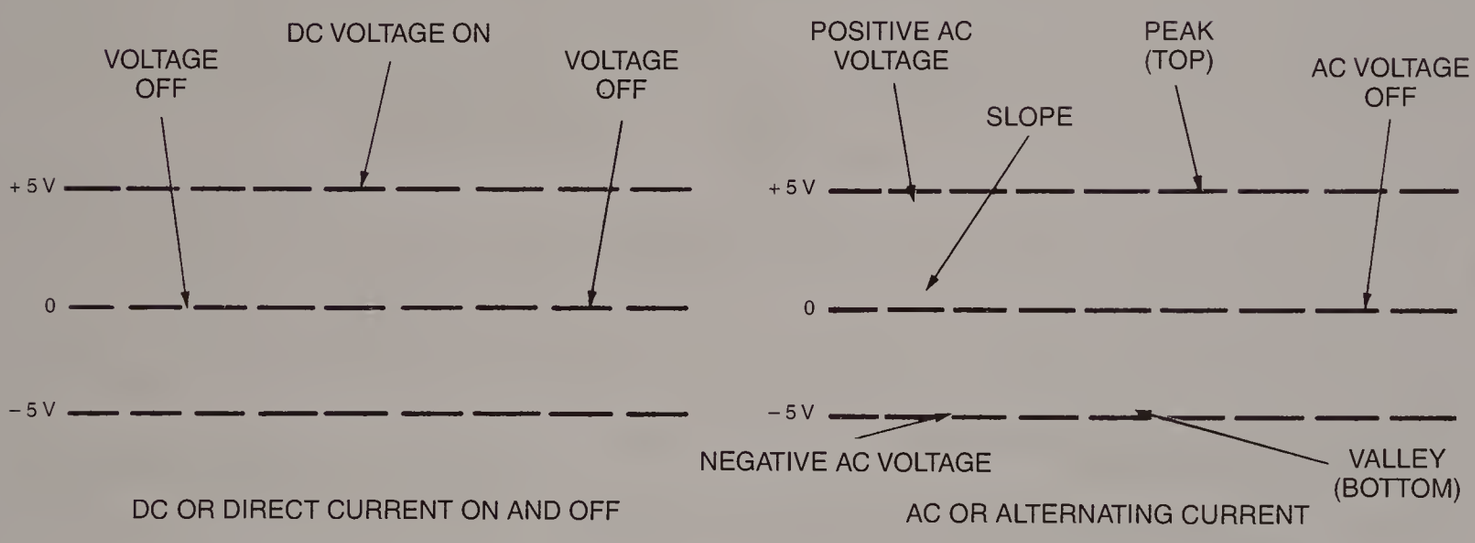
(A) A specific arrangement of pulses or waves that carries electronic data or information.
(B) A gradual increase or decrease in voltage and current over a length of time.
(C) A sudden increase or decrease in voltage or current.
(D) An unwanted voltage fluctuation in a circuit.

29. Pulse _____
30. Wave _____
31. Signal _____
32. Noise _____

33. Draw lines below to indicate voltages in a square wave and sine or analog wave.

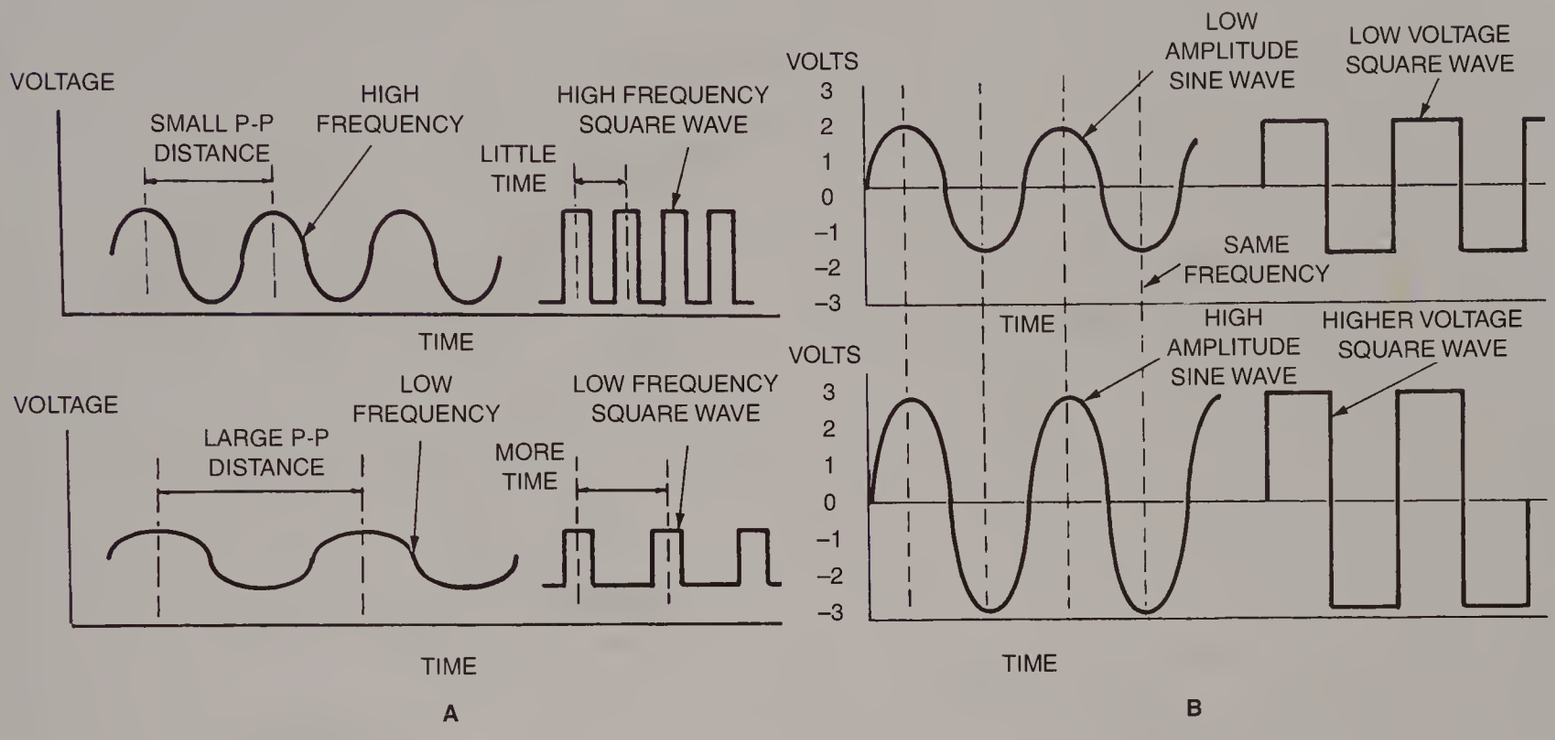
Square wave: _____

Sine or analog wave: _____



Name _____

34. Look at the illustrations below of how wave or pulse-voltage can vary. The taller a wave or pulse, the _____ (higher, lower) its voltage will be. 34. _____



Digital Electronics

35. A computer uses "artificial intelligence" by: 35. _____

(A) analyzing inputs or signals from sensors.
(B) using memory.
(C) making logical decisions on how to control specific outputs using the inputs.
(D) All of the above.

36. The _____ numbering system uses only two numbers and is the key to digital electronics and computers. 36. _____

37. A(n) _____ is an electronic circuit that produces a specific output for a given input. 37. _____

38. Identify the types of gates shown below.

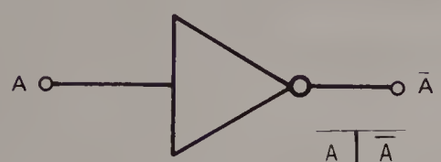
38. (A) _____

(B) _____

(C) _____

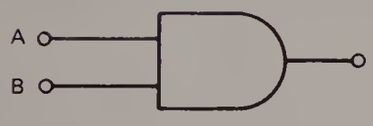
(D) _____

(E) _____



A	$\bar{A}$
1	0
0	1

A

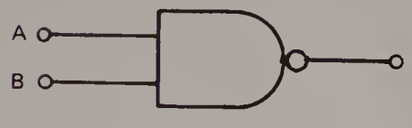


A	B	A • B
0	0	0
0	1	0
1	0	0
1	1	1

B

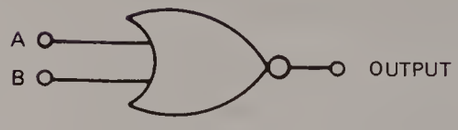
A	B	A + B
0	0	0
0	1	1
1	0	1
1	1	1

D



A	B	$\overline{A \bullet B}$
0	0	1
0	1	1
1	0	1
1	1	0

C



A	B	$\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

E

(General Motors Corporation)

39. A(n) _____ _____ is a chart that shows what the output of a gate will be with different inputs.

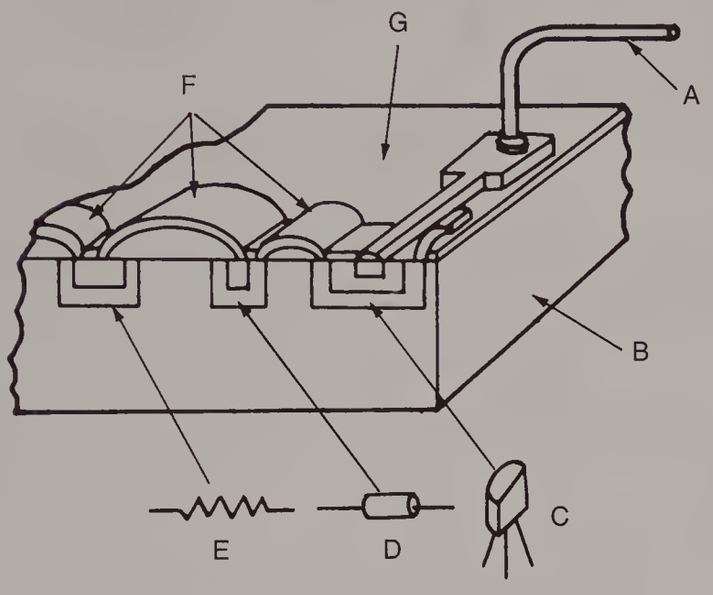
39. _____

40. An integrated circuit is an electronic circuit that has been reduced in size and placed on the surface of a tiny _____ chip.

40. _____

Name _____

41. Identify the parts indicated on this microscopic section of an IC chip.



41. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

- *Items 42 through 46.* Match the following terms with their descriptions.

(A) An integrated circuit containing complete amplifier circuits.
(B) An integrated circuit with a single row of in-line pins or terminals.
(C) An integrated circuit containing logic circuits.
(D) An IC that cannot change its output response from its original inputs.
(E) An integrated circuit with dual in-line pins.

42. Digital IC _____
43. Analog IC _____
44. Passive IC _____
45. DIP _____
46. SIP _____

Name _____

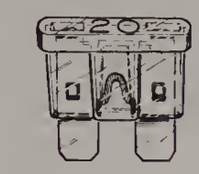
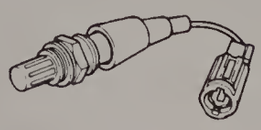
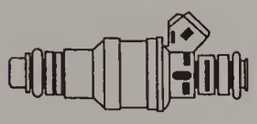
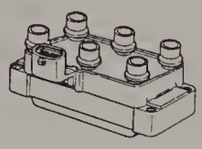
Date _____

Instructor _____

Score _____ Text pages 73–88

Chapter 6

Tools and Test Equipment

After studying this chapter and completing supplemental exercises, you will be able to:

- Identify the most common tools used during electrical repairs.
- Compare analog and digital multimeters.
- Explain conventional and inductive meter pickups.
- Summarize the use of basic and advanced test equipment.
- Select the proper tool or tester for the job.
- Describe the equipment needed to troubleshoot computer systems.
- More fully comprehend later textbook chapters.

Instructions: As you study Chapter 6 of the text, complete the following workbook problems in the spaces provided.

Soldering Tools

1. Soldering provides the best method for making a permanent _____ connection.

1. _____

2. A mixture of lead and tin is called _____.

2. _____

- *Items 3 through 6.* Identify the soldering equipment and briefly describe each one's use(s).

3. _____

_____

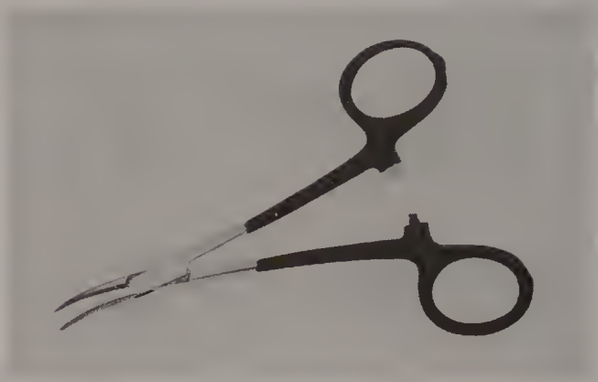
_____

4. _____

_____

_____

5. _____
_____
_____



6. _____
_____
_____

- *Items 7 through 10.* Briefly describe a use(s) for each of the following soldering tools.

7. Soldering brushes and picks:

_____

8. Sponges:

_____

9. Various tweezers:

_____

10. Small vise:

_____

Wire Stripping Tools, Pliers

- *Items 11 through 15.* Complete each statement by identifying the wire stripping tools and pliers described.

11. _____ _____ _____ are used in tight places during electrical repair and can grasp small components. 11. _____

12. The most handy for automotive applications, the _____ - _____ _____ _____ can strip insulation, crimp, and cut. 12. _____

13. _____ _____ _____ use a lever action to force insulation off of wires. 13. _____

Name _____

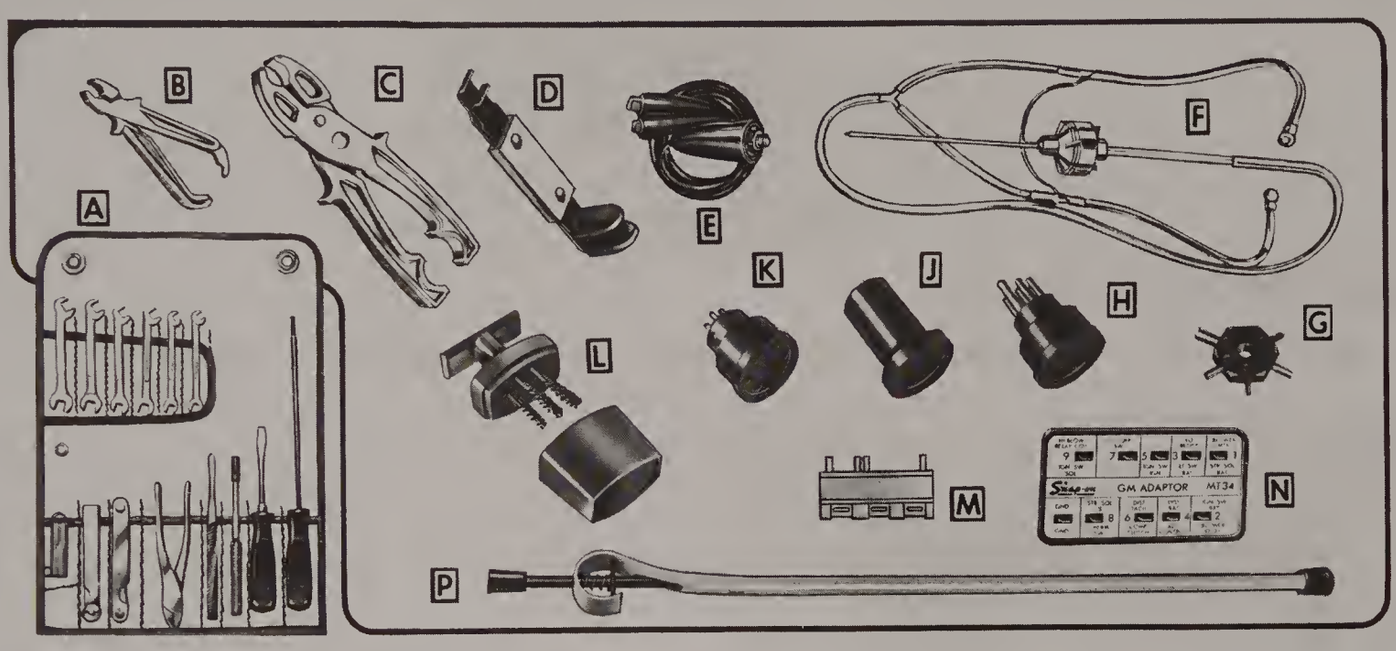
14. To cut wires off flush with a surface use _____ _____ _____ . 14. _____

15. Plastic or rubber insulation can be peeled from wires using _____ _____ _____, which do not have multiple jaws. 15. _____

Other Tools

16. In electrical repair, special _____ are needed for working with very small fasteners. 16. _____

17. Identify the items shown below.



(Snap-On Tools)

(A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(J) _____

(K) _____

(L) _____

(M) _____

(N) _____

(P) _____

18. Identify the tool below and describe its use.

_____

_____

_____

19. Identify the tool below and describe its use.

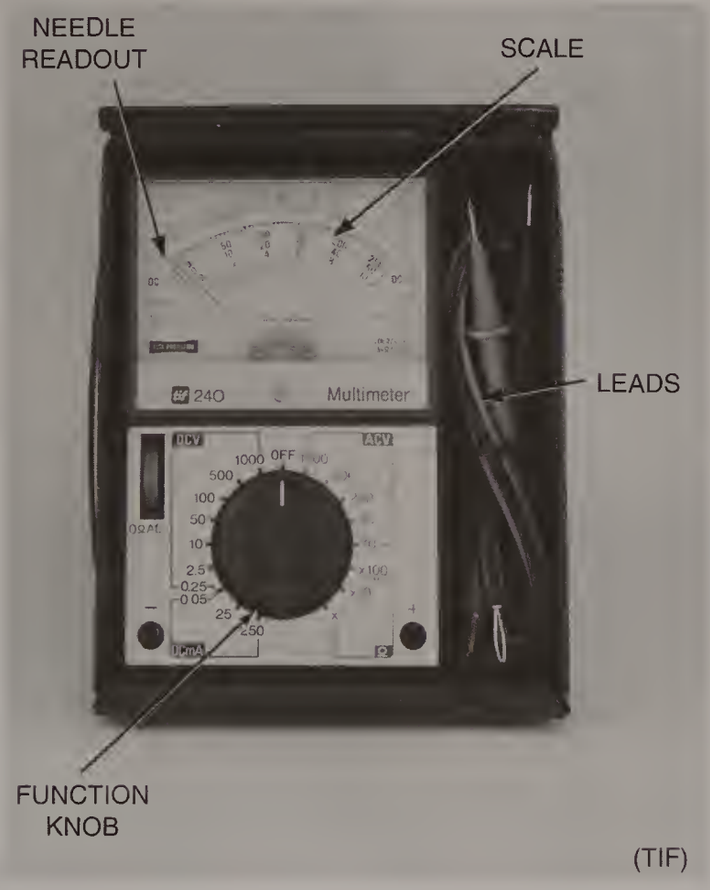
_____

_____

_____

Electrical Test Equipment

- *Items 20 through 22.* Identify the electrical test equipment and briefly describe each one's use(s).



20. _____

_____

_____

21. _____

_____

_____

Name _____

22. _____

_____

_____

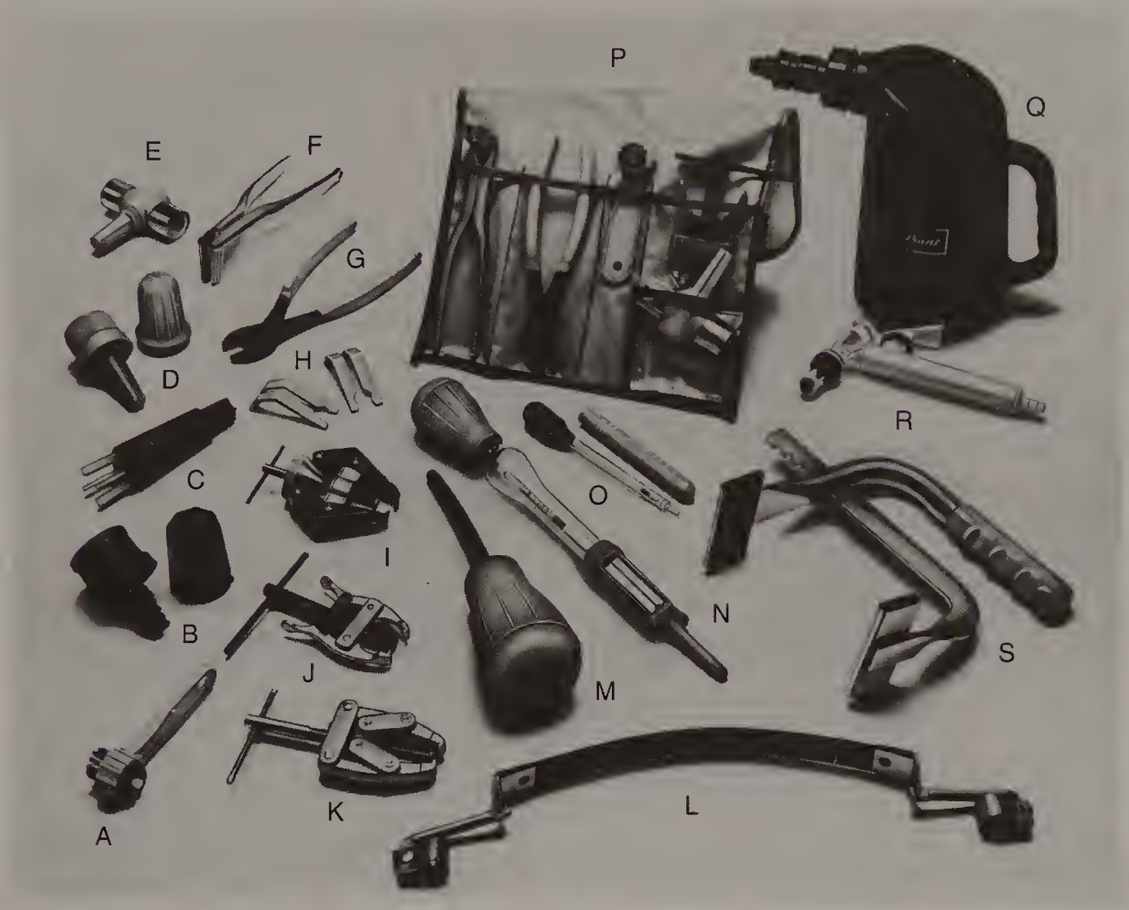
- *Items 23 through 28.* Match the following electrical test equipment with its description.

23. Common circuit-powered test light — 23. _____
24. Inductive meter — 24. _____
25. Tach-dwell meter — 25. _____
26. Self-powered test light — 26. _____
27. Inductive wire tracer — 27. _____
28. Digital temperature probe — 28. _____

(A) Uses circuit voltage to illuminate tester bulb.
(B) Measures engine speed or rpm for various tests, adjustments, and repairs.
(C) Makes quick and accurate temperature measurements.
(D) Uses a small battery to check a circuit for continuity.
(E) A clip-on multimeter handy for making current readings.
(F) Finds internal breaks in wires and disconnected wires or terminals.

Battery Charging, Starting System Service Tools

29. Identify the battery-related service tools shown below.



(A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____

30. To measure battery voltage as a means of checking battery condition, a technician can use a(n) _____ _____. 30. _____

31. A technician uses _____ _____ _____ for starting an engine by connecting a dead battery to a charged battery. 31. _____

32. A(n) _____ _____ is used to check a battery, the charging system, and the starting system. 32. _____

Name _____

33. To check the output of an alternator off the car, use a(n) _____ _____ _____. 33. _____

Ignition System Test Equipment

- *Items 34 through 36.* Identify the ignition system test equipment below and briefly describe each one's use(s).

34. _____
_____
_____

35. _____
_____
_____

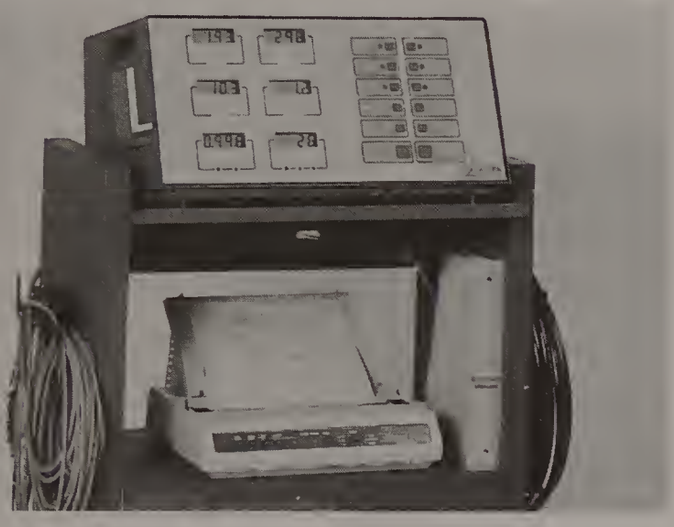
36. _____
_____
_____

37. A(n) _____ _____ reads light flashes from reflective tape on engine crankshaft damper and can be used on diesels. 37. _____

38. A(n) _____ _____ adjusts ignition timing on gasoline or spark ignition engines. 38. _____

Exhaust Gas Analyzer

39. Identify the item below and briefly describe its use(s). 39. _____



(Allen Testproducts)

Diesel Service Tools

40. A diesel engine does not use an electrical _____ system. 40. _____

41. Identify the diesel service tools and briefly describe the use(s) of each one.

(A) _____

(B) _____

Name _____

Other Test Equipment

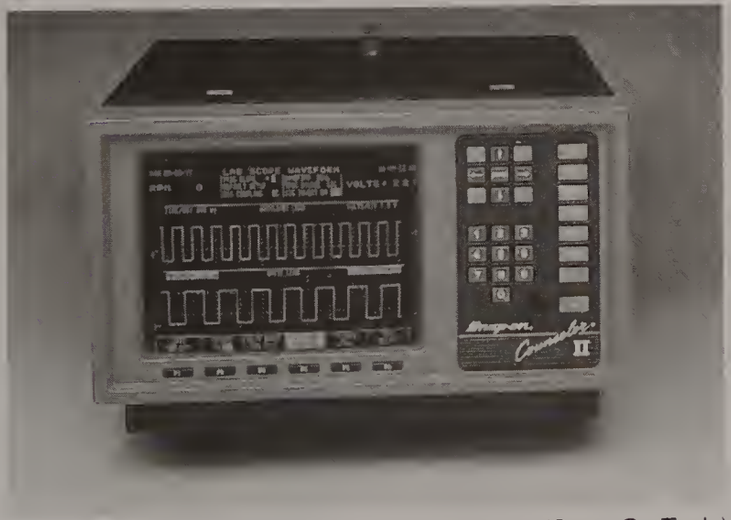
- *Items 42 through 45.* Identify the test equipment below and briefly describe each one's use(s).

(OTC)

42. _____

_____

_____



(Snap-On Tools)

43. _____

_____

_____

(OTC)

44. _____

_____

_____

(Sun Electric)

45. _____

_____

_____

Name _____

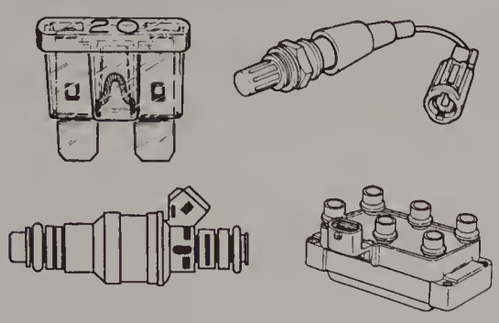
Date _____

Instructor _____

Score _____ Text pages 89–106

Chapter 7

Wiring, Wiring Repairs



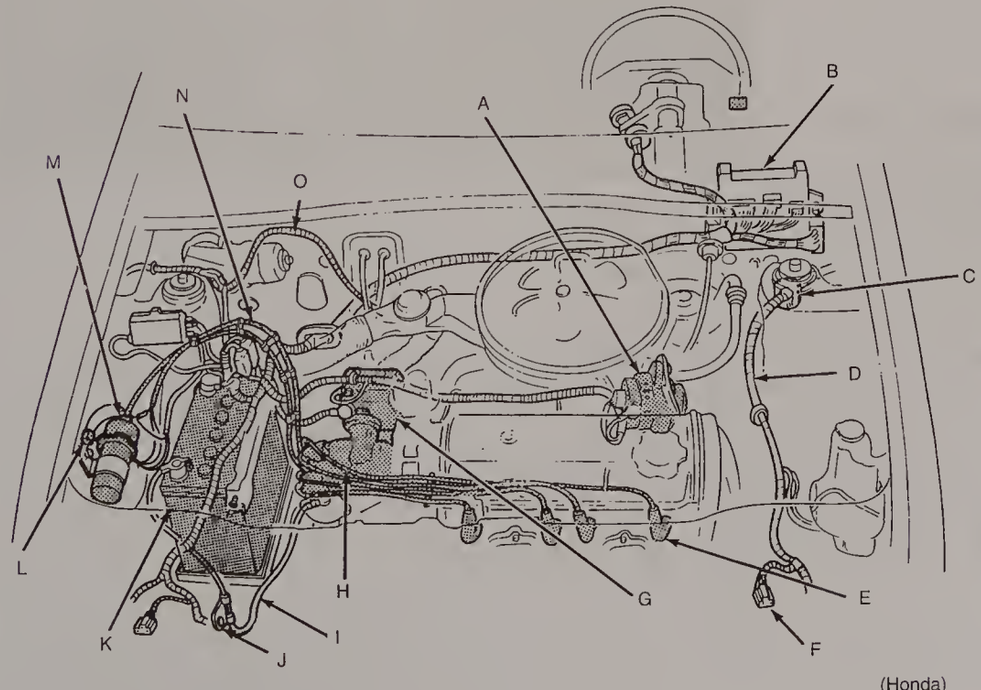
After studying this chapter and completing supplemental exercises, you will be able to:

- Summarize the importance of making proper wiring repairs on a modern car.
- Compare wire types and sizes.
- Explain wire color coding.
- Describe wire protection devices.
- Properly cut and strip wires.
- Solder wires and terminals.
- Use crimp type connectors.
- Explain connector types.
- Service automotive type connectors.
- Repair wires, connectors, and fusible links.

Instructions: As you study Chapter 7 of the text, complete the following workbook problems in the spaces provided.

Automotive Wiring

1. Identify the various parts indicated on the illustration below.



(Honda)

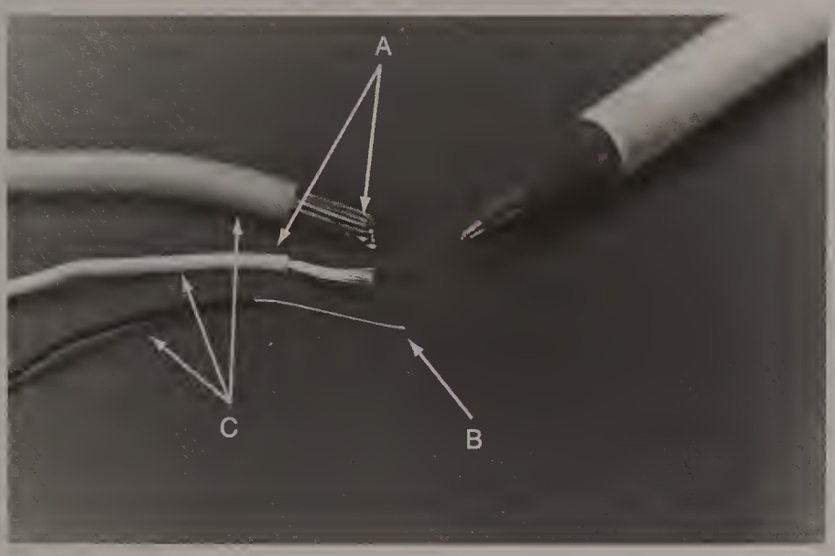
1. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____

2. Identify the types of wires shown below.

2. (A) _____

(B) _____

(C) _____



3. Wire size:

3. _____

(A) never limits how much current a wire can carry without overheating.

(B) includes the thickness or diameter of the insulator.

(C) is determined by the diameter of the conductor.

(D) must not be matched to the circuit load or amperage draw.

4. A 14 gauge wire is _____ (smaller, larger) than a 12 gauge wire. 4. _____

5. Car wiring is usually between: 5. _____

(A) 4 and 6 gauge.

(B) 8 and 20 gauge.

(C) 16 and 20 gauge.

(D) 8 and 16 gauge.

6. In the chart below, list the AWG size in gauge size.

Metric wire size in mm²			AWG size in gauge size
.22	_____	Smallest	_____
.5	_____	_____	_____
.8	_____	_____	_____
1.0	_____	_____	_____
2.0	_____	_____	_____
3.0	_____	_____	_____
5.0	_____	_____	_____
8.0	_____	_____	_____
13.0	_____	_____	_____
19.0	_____	_____	_____
32.0	_____	Largest	_____

Name _____

7. As conductor diameter decreases, wire resistance _____ (decreases, increases). 7. _____

8. _____ is dependent upon the material used in the conductor. 8. _____

9. As the length of the wire increases, resistance _____ (decreases, increases). 9. _____

10. In most conductors, as temperature increases, resistance _____ (decreases, increases). 10. _____

11. A conductor can be heated or its insulation melted or burned by excess _____. 11. _____

12. Always replace a wire with the same wire _____ size. 12. _____

13. Huge wires that carry battery current to the starting motor and return current to the battery from ground are called _____. 13. _____

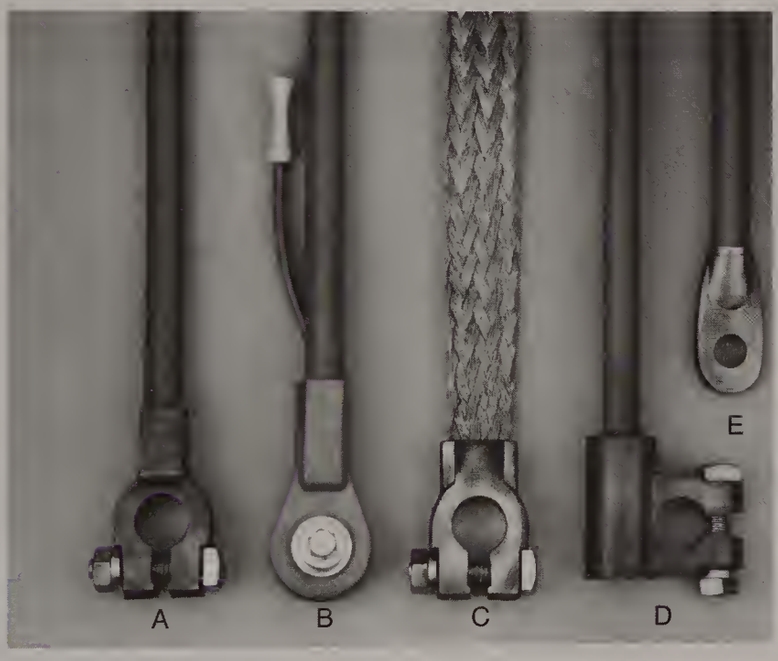
14. Identify the battery cables shown in the photo below. 14. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____



15. What is the difference between primary and secondary wire?

_____

_____

_____

_____

16. When soldering during an electrical repair, only use _____ _____ (acid core, rosin core) solder. 16. _____

17. (Secondary, Shielded) _____ wire has the center conductor surrounded by an outer metal shield. 17. _____

18. Copper foil bonded on a plastic or fiber base to form compact conductors is found on _____ _____ wiring. 18. _____

19. Aluminum wire must be _____ (larger, smaller) in diameter to carry the same current as copper. 19. _____

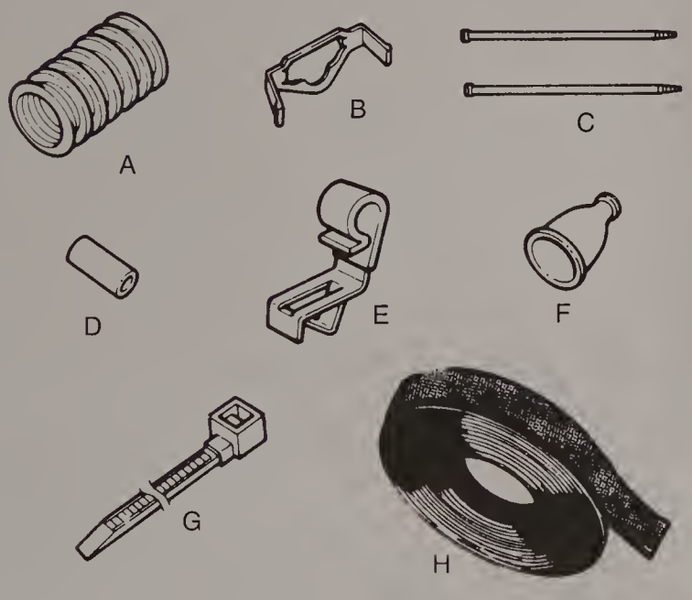
20. Why is color coding used on the insulation of wires? _____

_____

_____

21. Identify the wire protection devices shown below.

21. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

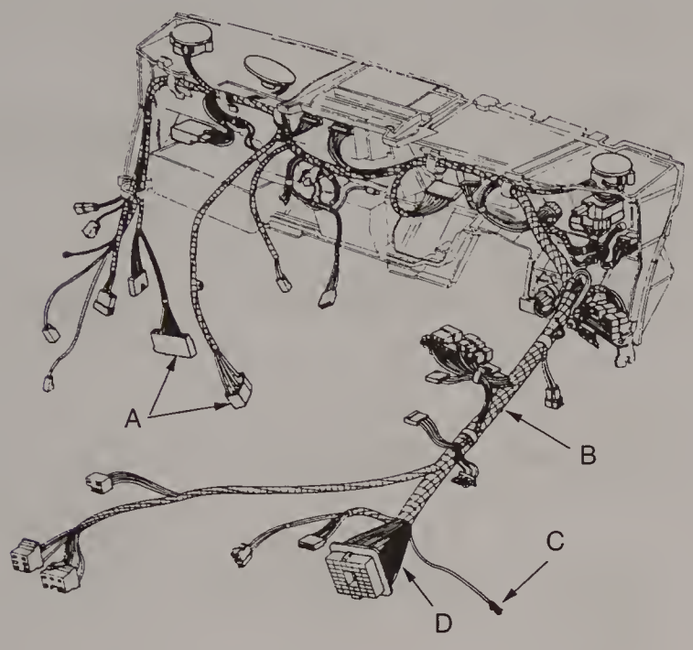


(Chrysler)

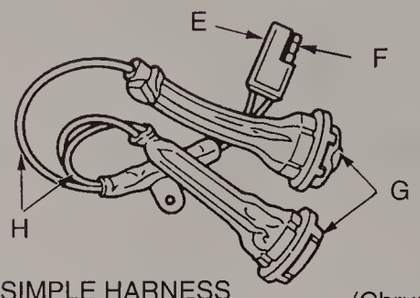
Name _____

22. Identify the parts indicated on the wiring harnesses below.

22. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____



COMPLEX HARNESS



SIMPLE HARNESS (Chrysler)

Wiring Repairs

23. When cutting wire:

23. _____

(A) cut part way through, and then cut again.
(B) cut all the way through on the first try.
(C) make no new cuts when joining the wire to another component.
(D) try to get uneven strands on the wire end.

24. Why is stripping off insulation using cutting pliers not recommended? _____

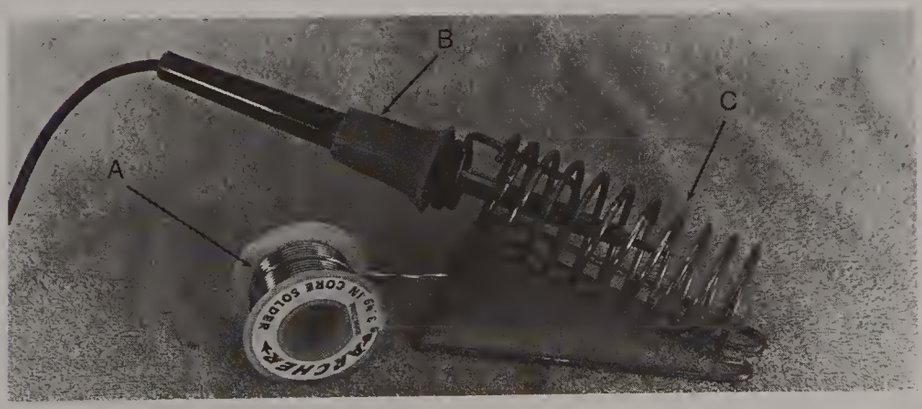
_____

_____

Soldering

25. Identify the items indicated in the photo below.

25. (A) _____
(B) _____
(C) _____



26. Cleaning and preparing the surface of the soldering gun tip and/or the electrical components is done by _____. 26. _____

27. Explain why electrical components must be preheated sufficiently before melting solder onto a joint.

_____

_____

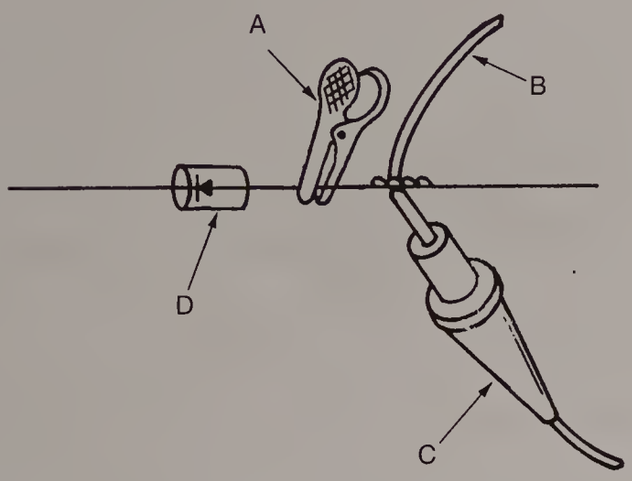
_____

28. Identify the items in the diagram below. 28. (A) _____

(B) _____

(C) _____

(D) _____



29. Which of the following is the best choice to protect a conductor from moisture? 29. _____

(A) Masking tape.

(B) Liquid electrical tape.

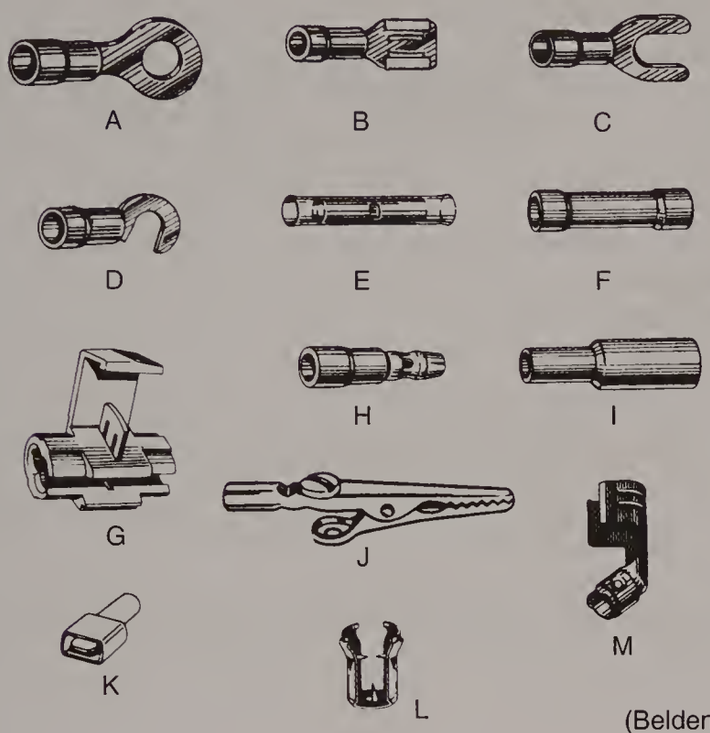
(C) Electrical tape.

(D) None of the above.

Name _____

Wire Terminals and Connectors

30. Identify the single wire connectors and terminals below.



(Belden)

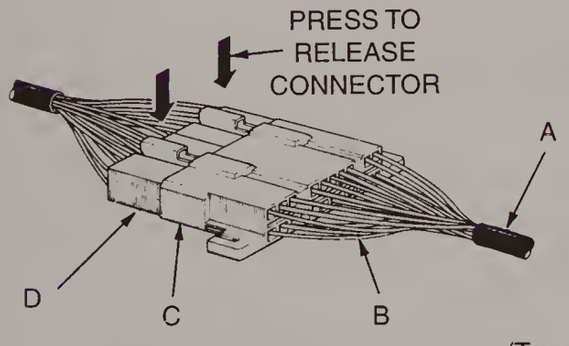
30. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____

31. If a wire were to pull out of a crimp connector, it could cause a(n) _____.

31. _____

Factory Connectors

32. Identify the parts indicated on the factory connector below.



(Toyota)

32. (A) _____
(B) _____
(C) _____
(D) _____

33. Before refastening connectors, it is usually recommended that you apply _____ to the terminals to help prevent corrosion.

33. _____

34. A(n) _____ - _____ _____ will cut through the wire insulation and lock onto the wire conductor automatically.

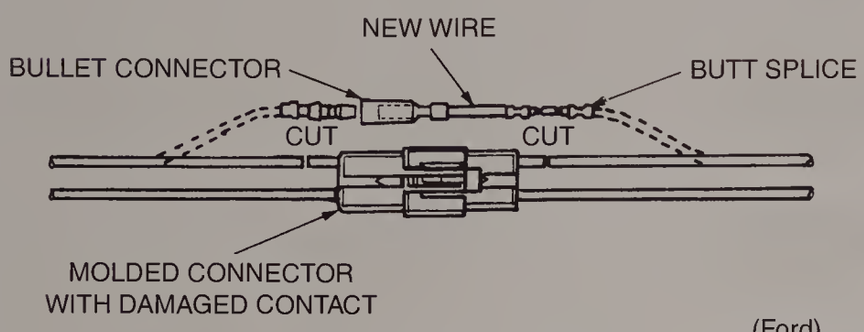
34. _____

Wiring Repairs

35. What has been done in the diagram below? _____

_____

_____

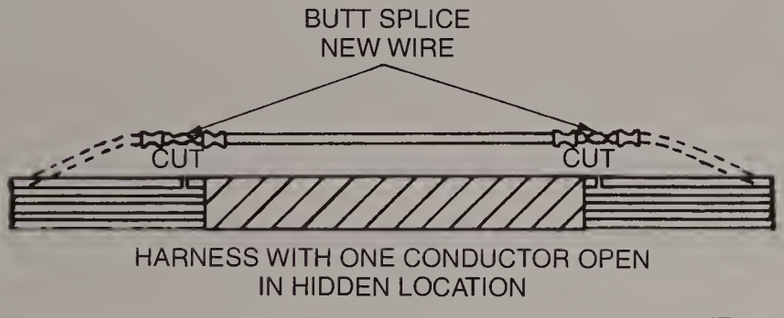


(Ford)

36. What has been done in the diagram below? _____

_____

_____



(Ford)

37. Before replacing a(n) _____ _____, correct the short circuit problem. 37. _____

38. Describe the steps to take in replacing a fuse link. _____

_____

_____

_____

_____

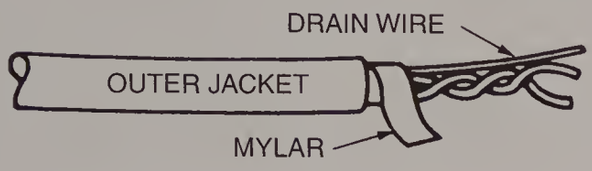
_____

Name _____

39. List the six steps necessary for repairing twisted-shielded wire for a computer wiring harness.

1. _____
2. _____
3. _____

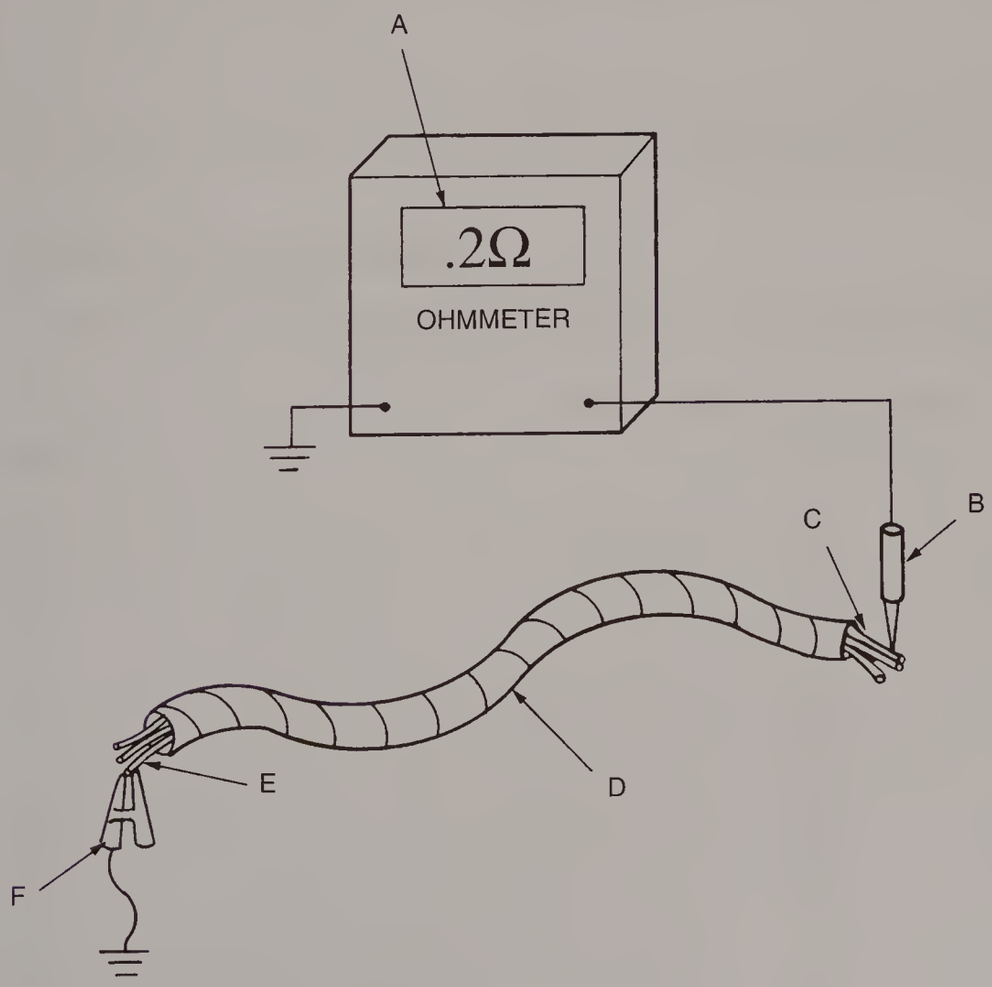
TWISTED/SHIELDED CABLE



4. _____
5. _____
6. _____

40. Identify the items indicated in the basic harness wire test below.

40. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

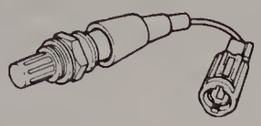
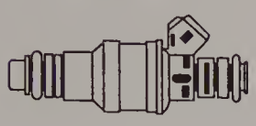
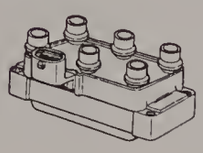


Name _____

Date _____

Instructor _____

Score _____ Text pages 107–134

Chapter 8

Using Wiring Diagrams and Manuals

After studying this chapter and completing supplemental exercises, you will be able to:

- Explain common abbreviations found in service manuals.
- Use different types of troubleshooting charts.
- Use alpha-numeric wiring code identification systems.
- Use component location charts and illustrations.
- Read electrical circuit diagrams.
- Locate specific components on wiring diagrams using a grid.
- Describe variations in wiring diagrams from different auto manufacturers.
- Use the information charts that accompany many wiring diagrams.
- Use connector illustrations when testing a circuit.
- Explain vacuum diagrams.
- Identify basic vacuum component symbols.

Instructions: As you study Chapter 8 of the text, complete the following workbook problems in the spaces provided.

Using Service Manuals

1. Identify the terms represented by the abbreviations often used in service manuals.

SAE-Recommended Abbreviations

Abbreviations	Term	Abbreviations	Term
AP	_____	IFS	_____
AC	_____	IA	_____
A/C	_____	IAT	_____
A/T	_____		
A/T	_____	KS	_____
BARO	_____	MIL	_____
B+	_____	MAP	_____
		MDP	_____
CMP	_____	MST	_____
CARB	_____	MVZ	_____
CAC	_____	MAF	_____
CL	_____	MC	_____
CTP	_____	MFI	_____
CPP	_____		
CFI	_____	NVRAM	_____
CTOX	_____		
CKP	_____	OBD	_____

(continued)

(continued)

SAE-Recommended Abbreviations (continued)

DLC _____
DTM _____
DTC _____
DFI _____

EFE _____
EGRT _____
EEPROM _____
_____
EI _____
EC _____
ECM _____
ECL _____
ECT _____
EM _____
RPM _____
EPROM _____
_____
EVAP _____
EGR _____

FC _____
FEEPROM _____
_____
FEPROM _____
_____
FF _____
4GR _____
FP _____
FT _____

GEN _____
GCM _____
GND _____

HO^2S _____

IAC _____
ISC _____
IC _____
ICM _____
IFI _____

OL _____
OC _____
O^2S _____

PNP _____
PTOX _____
PCV _____
PSP _____
PCM _____
PROM _____
PAIR _____

RAM _____
ROM _____
RM _____

ST _____
AIR _____
SFI _____
SRI _____
SPL _____
SC _____
SCB _____
SRT _____

TVV _____
3GR _____
TWC+OC _____
TWC _____
TB _____
TBI _____
TP _____
TCC _____
TCM _____
TR _____
TC _____

VSS _____
VR _____
VAF _____

WU-TWC _____
WOT _____

2. Which of the following gives logical steps for finding and correcting problems? 2. _____

   (A) Diagnosis or troubleshooting charts.
   (B) Repairing procedures.
   (C) Electrical specifications.
   (D) References.

3. Why is it critical that you refer to electrical specifications when doing electrical repairs?

_____

_____

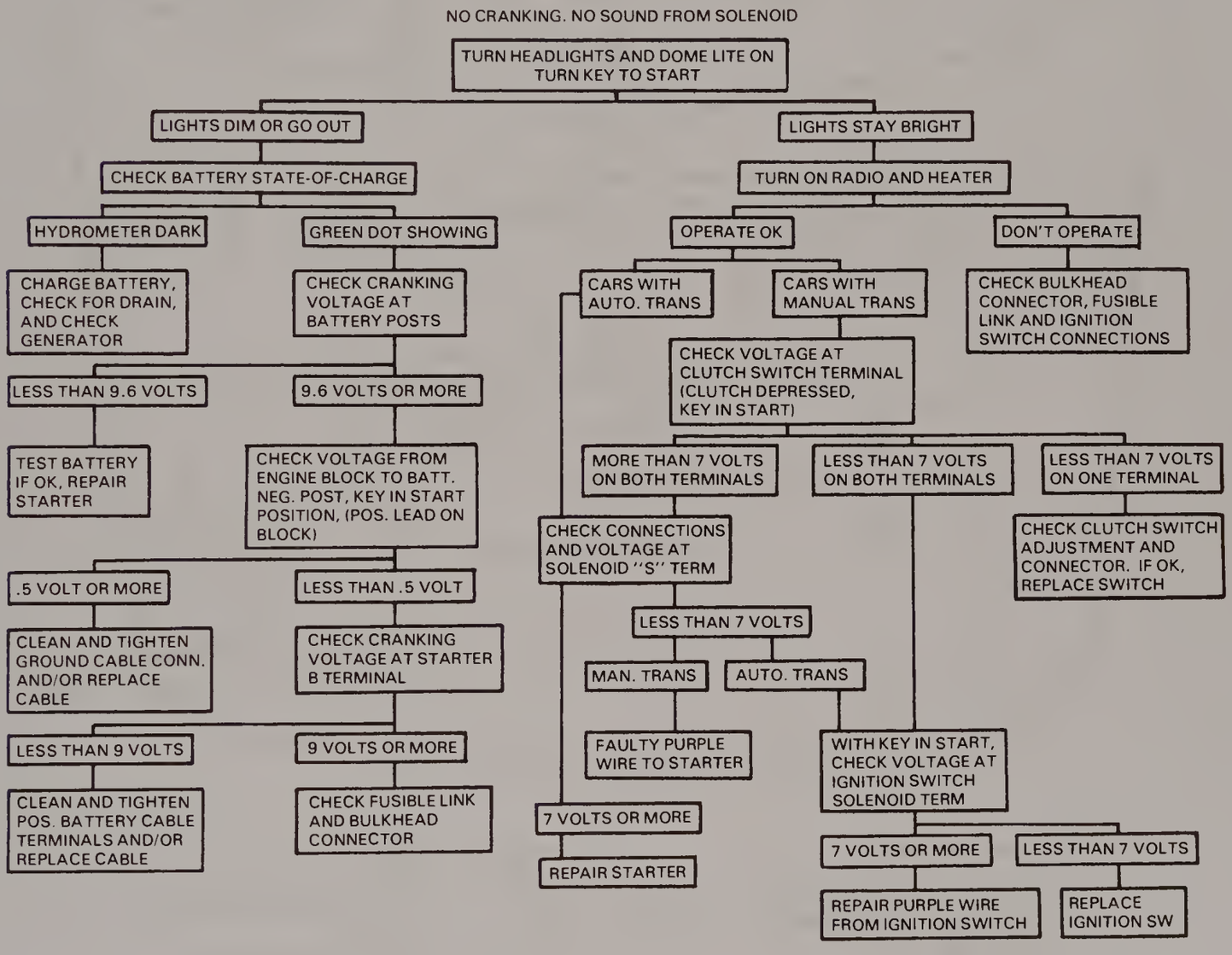
Name _____

4. Look at the diagnosis chart below. Suppose that the headlights are dim or go out. You have checked the voltage from the engine block to the negative post of the battery with the key in the start position. There is .5 volt or more. What is the next step?

_____

_____

_____



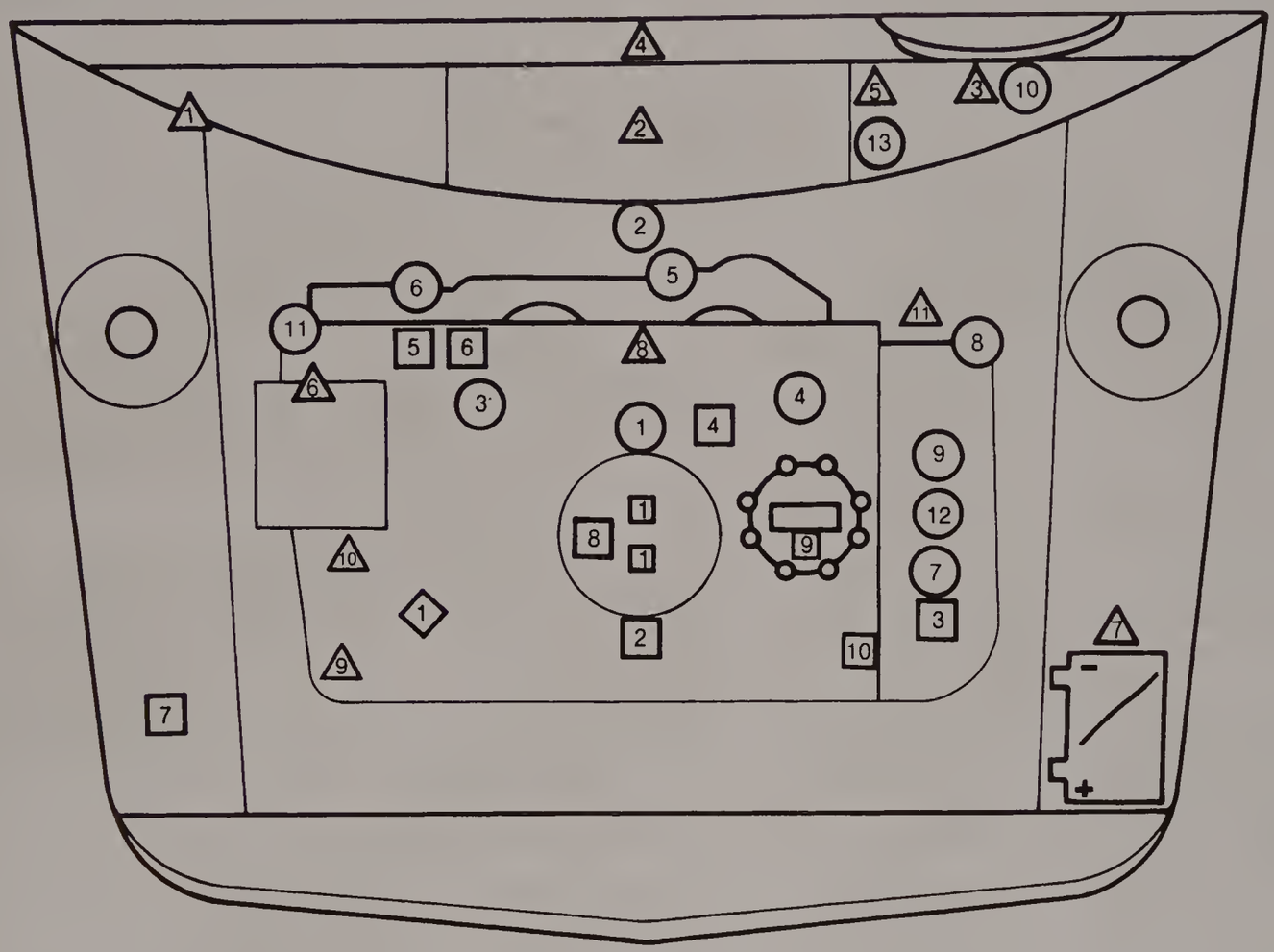
(General Motors)

Component Locations

5. Look at the top view of the engine compartment below. Identify the symbols used to find the various components below.

   (A) VCC brake.
   (B) Fuel injectors.
   (C) Climate control panel.

5. (A) _____
   (B) _____
   (C) _____



△ COMPUTER HARNESS

1 ECM (ELECTRONIC CONTROL MODULE)
2 ALDL CONN. (DIAGNOSTIC LINK)
3 "SERVICE NOW," "SERVICE SOON"
4 CLIMATE CONTROL PANEL
5 FUSE PNL (DASH-ECM)
6 GEN. GND.
7 SINGLE PT. GND.
8 TPS TEST PT (THROTTLE SWITCH)
9 O_2 REFERENCE GROUND
10 GENERATOR DISABLE CONNECTOR
11 FUEL PUMP TEST POINT

◇ NOT ECM CONNECTED

1 PCV (POSITIVE CRANKCASE VENT)

○ INFORMATION SENSORS

1 TPS
2 MAP
3 MAT
4 CTS
5 O_2
6 VSS
7 3RD AND 4TH SW (THROTTLE SWITCH)
8 P/N SAFETY (MANIFOLD PRESSURE)
9 OIL PRESSURE
10 VCC BRAKE
11 PS CUTOUT (POWER STEERING)
12 TRANS TEMP
13 CALIBRATION TIMER MODULE

□ CONTROLLED DEVICES

1 FUEL INJECTORS
2 ISC MOTOR (IDLE SPEED)
3 VCC
4 EGR SOL. (EXHAUST GAS)
5 AIR DIV. SOL.
6 AIR SW. SOL.
7 CANISTER SOL.
8 EFE (EVAPORIZATION)
9 DISTRIBUTOR
10 CRUISE CONTROL

Name _____

Wiring Diagrams

6. In wiring diagrams, symbols represent _____. 6. _____

7. In wiring diagrams, lines represent _____. 7. _____

8. Identify the typical body parts indicated on the car below. 8. (A) _____

(B) _____

(C) _____

(D) _____

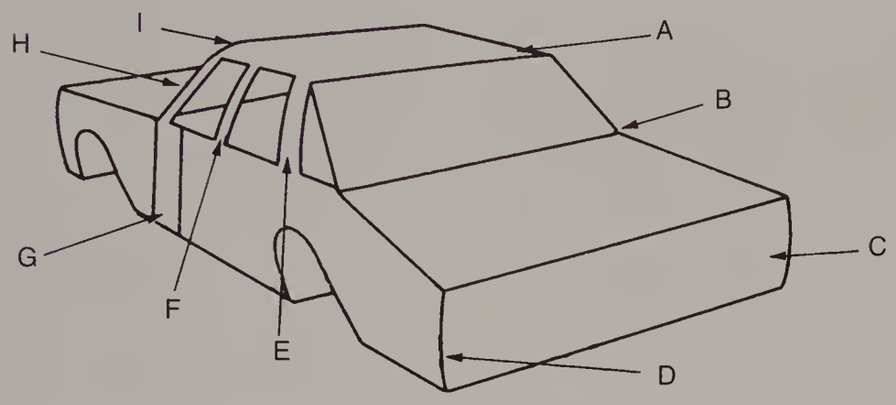
(E) _____

(F) _____

(G) _____

(H) _____

(I) _____



9. The _____ - _____ _____ _____ is a number-letter method for explaining the appearance, location, and gauge size of conductors on a wiring diagram. 9. _____

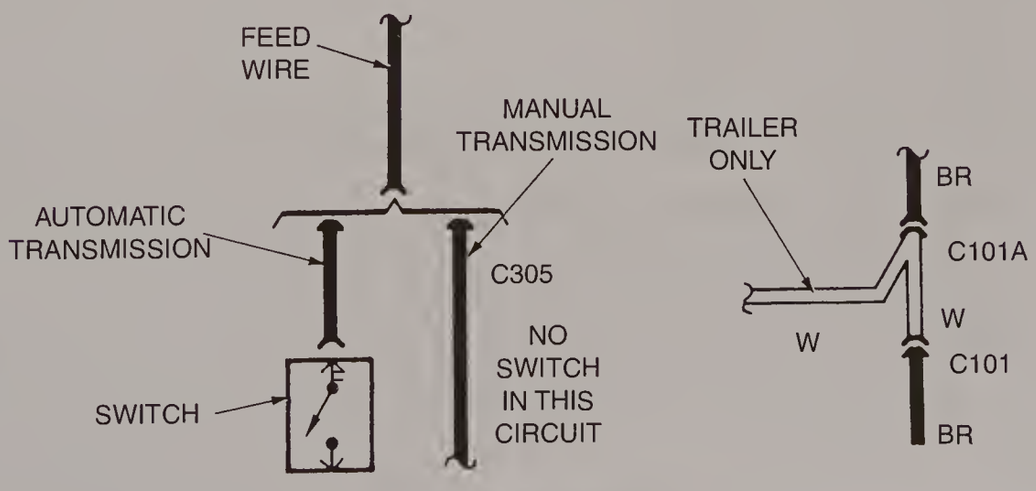
10. A(n) _____ _____ _____ shows how major wiring is arranged and located in the car. 10. _____

11. Wiring splices are normally shown on a wiring diagram by a(n) _____ where the wires connect. 11. _____

12. _____ show where a circuit connects to the frame or chassis of a car. 12. _____

13. Identify the types of diagrams below. 13. (A) _____

(B) _____



A B

14. A(n) _____ _____ is a terminal that allows several wires to connect together. 14. _____

15. Connector _____ show which connector terminals should be touched or tested when troubleshooting. 15. _____

16. _____ _____ _____ are specifications given for voltage, current, and resistance for a known good circuit. 16. _____

17. List eight tips for using wiring diagrams. _____

_____

_____

_____

_____

_____

_____

_____

18. On the wiring diagram below, identify what the symbols and abbreviations mean.

18. (A) _____

(B) _____

(C) _____

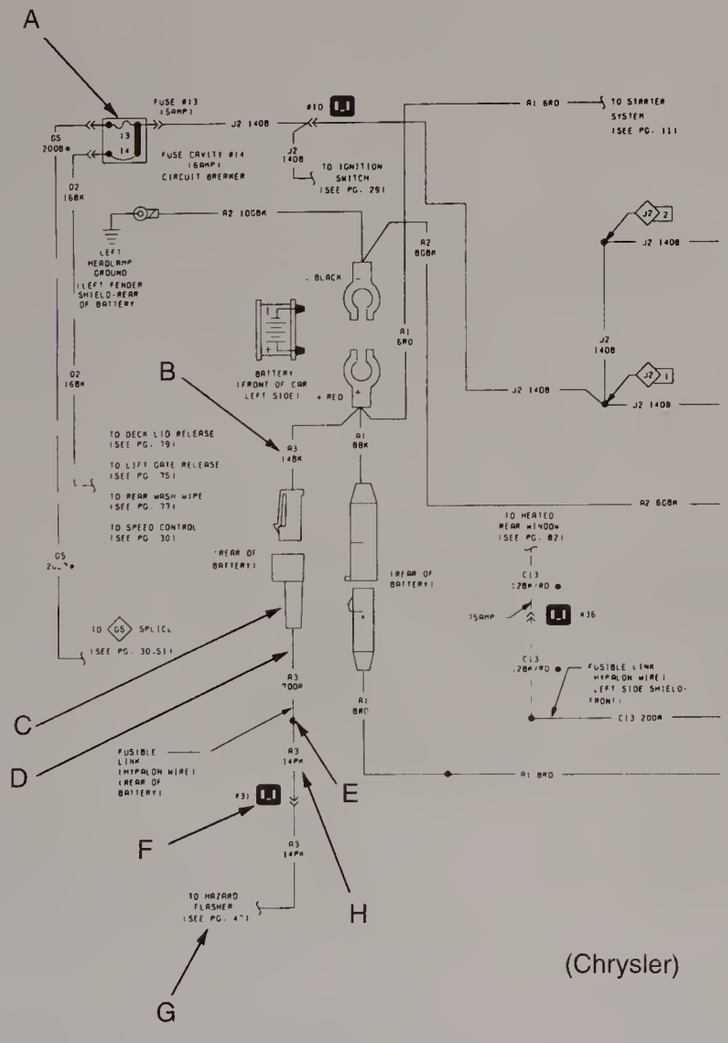
(D) _____

(E) _____

(F) _____

(G) _____

(H) _____



(Chrysler)

Name _____

19. On the wiring diagram below, identify what the symbols and abbreviations mean.

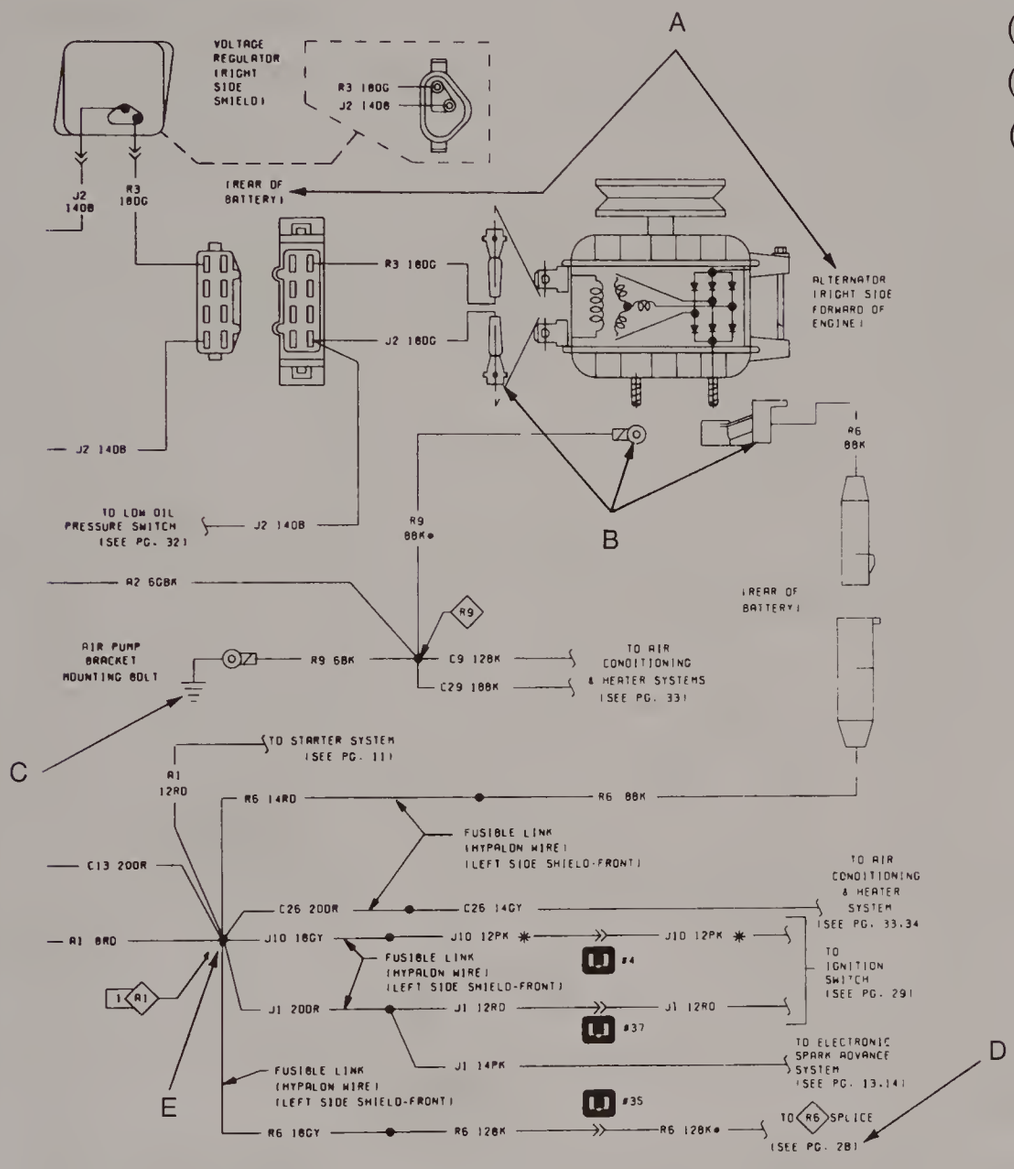
19. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____



(Chrysler)

20. A(n) _____ _____ _____ shows how battery current feeds to the main components or sections of the car's electrical system.

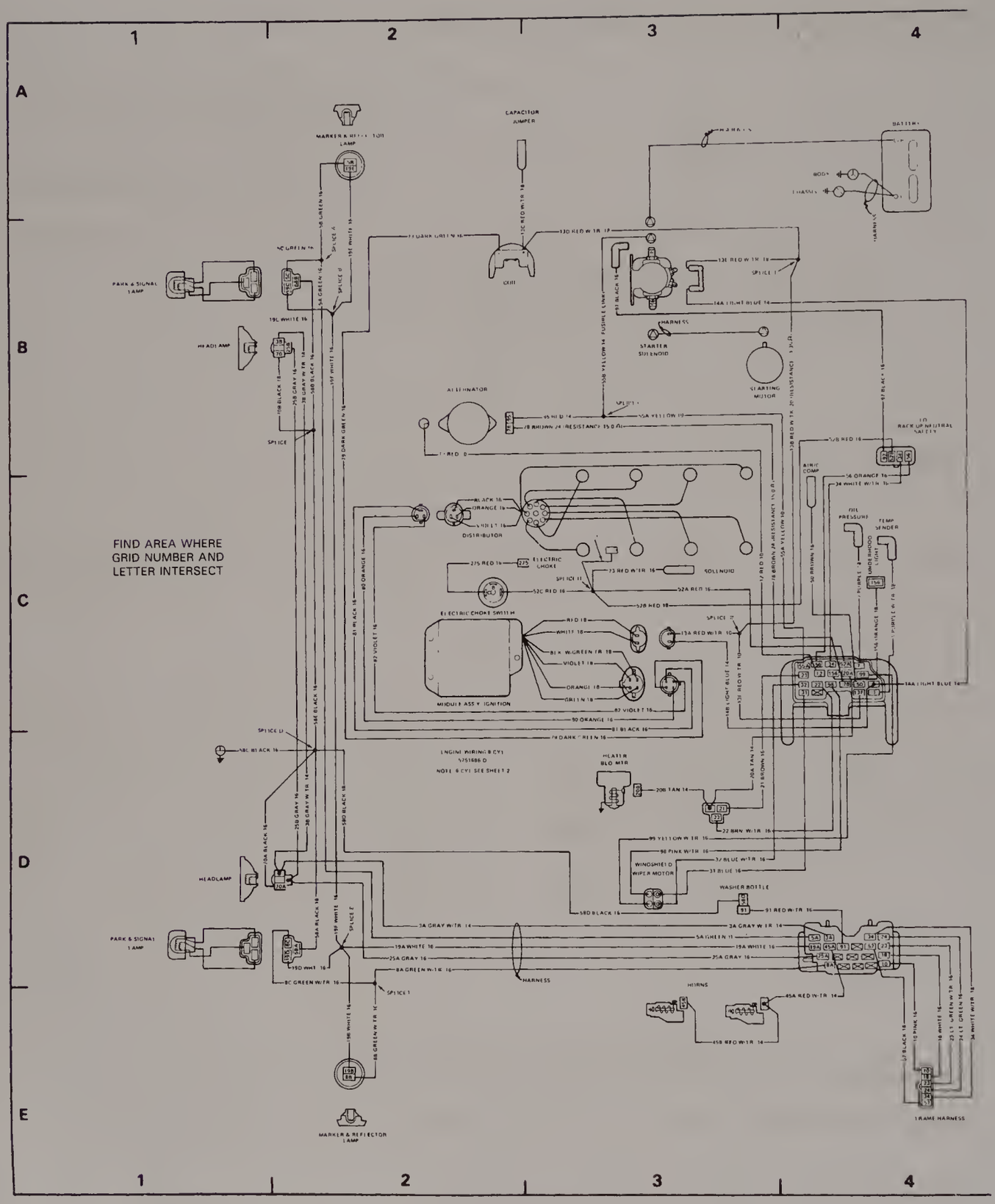
20. _____

21. Using the location grid on following page, what components are located in the area 3D?

_____

_____

_____



22. A(n) _____ _____ _____ is a large diagram containing symbols for all major wiring and electrical-electronic components on a car. 22. _____

23. A system wiring diagram only contains the components and wires for a particular _____ . 23. _____

Name _____

24. The _____ _____ uses simple boxes to show components and lines to show wires, hoses, or metal lines. 24. _____

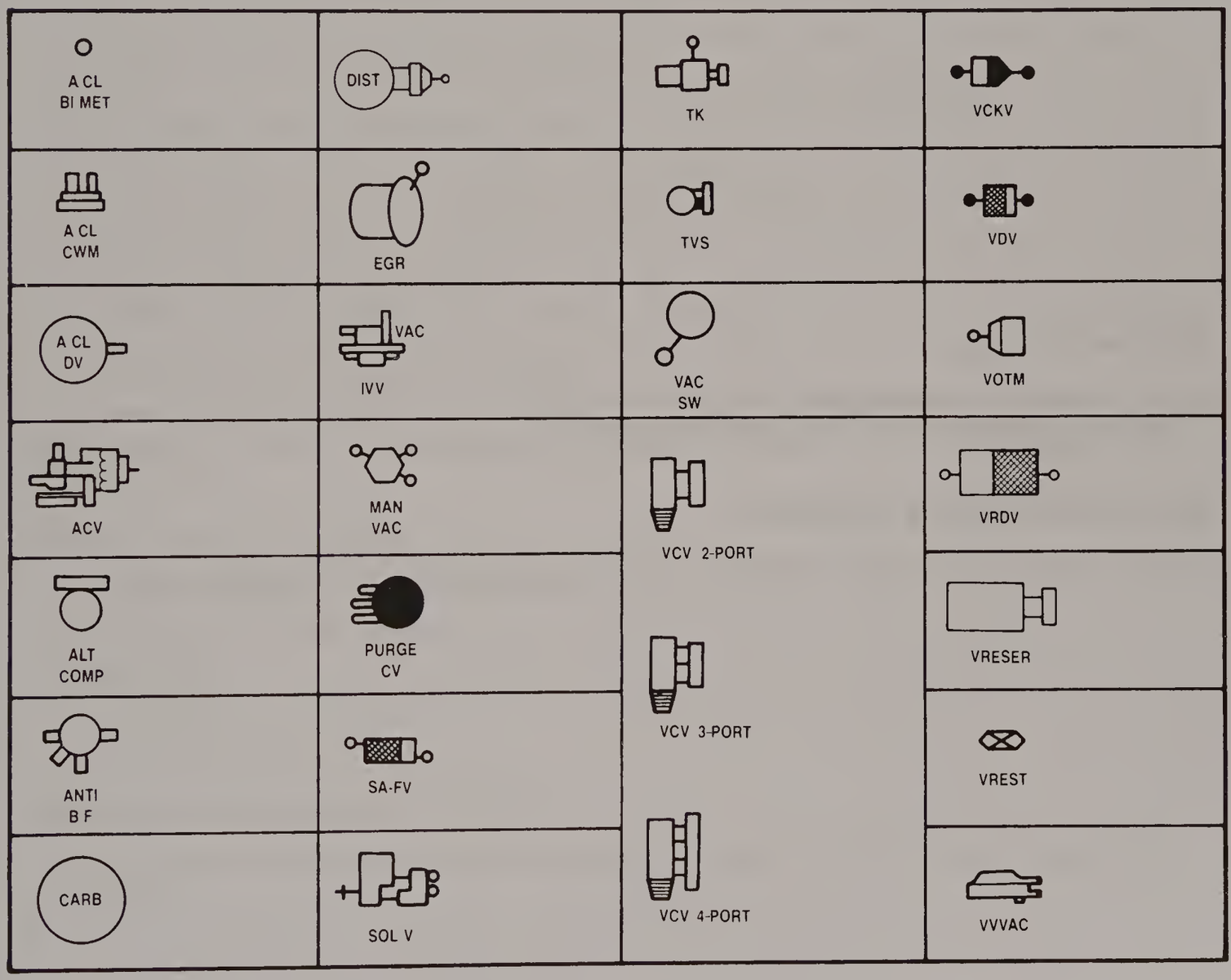
Vacuum Diagram

25. If you were an electronic technician, why would you need to know how to work with vacuum diagrams?

_____

_____

26. Identify the typical vacuum component symbols below.



(Ford)

Technical Service Bulletins

27. Technical service bulletins help technicians stay up-to-date with recent: 27. _____

(A) technical changes.

(B) recalls.

(C) other service-related information.

(D) All of the above.

Computerized Service Data

28. List seven types of service-related information that can be stored in a computer system.

_____

_____

_____

_____

_____

_____

_____

On-Line Services

29. _____ sites allow service facilities to find service information that is not available in the manuals or electronic media they have on hand. 29. _____

Technical Assistance Hotlines

30. Why is it helpful for technicians to speak to technical support personnel on technical support hotlines?

_____

_____

_____

Name _____

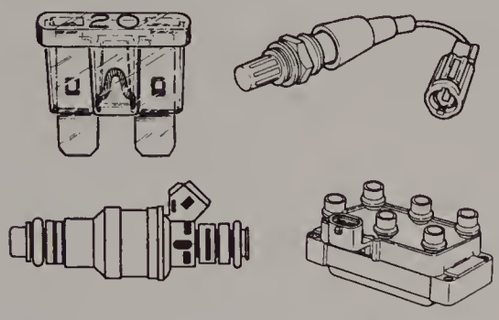
Date _____

Instructor _____

Score _____ Text pages 135–158

Chapter 9

Basic Electrical Tests, Circuit Problems



After studying this chapter and completing supplemental exercises, you will be able to:

- Use a systematic approach to find and correct electrical problems.
- Describe the symptoms and causes of an open circuit.
- Describe the symptoms and causes of a short circuit.
- Explain how shorts and opens have different effects on different circuit configurations.
- Use a jumper wire to check component operation.
- Use a test light or a multimeter to check for voltage in a circuit.
- Use a self-powered test light or an ohmmeter to check for continuity.
- Use a test light, compass, or inductive tester to find a short.
- Read the scales on an analog multimeter.
- Describe when to use a digital meter instead of an analog meter.
- Measure and use voltage drops to check resistances in a circuit.
- Test basic electrical and electronic components.

Instructions: As you study Chapter 9 of the text, complete the following workbook problems in the spaces provided.

Basic Circuit Problems

1. A basic circuit problem is caused by something in the circuit that increases or decreases:

   (A) current.
   (B) resistance.
   (C) voltage.
   (D) Any of the above.

1. _____

Electrical Diagnosis and Repair

2. List the proper sequence for finding and fixing electrical problems. (Hint: "Veronica never touches much voltage.")

_____

_____

_____

_____

_____

_____

3. List five questions to ask yourself when trying to find the source of electrical problems.

4. The best approach to take when trying to find or correct electrical problems is using a(n) _____ sequence of steps. 4. _____

5. List the seven steps to a systematic approach to troubleshooting.

Types of Circuit Problems

6. Which of the following is caused by a conductor accidentally touching ground or another conductor? 6. _____

   (A) Open circuit.

   (B) High circuit resistances.

   (C) Short circuit.

   (D) Intermittent problem.

Name _____

7. List five ways an open circuit can be caused.

_____

_____

_____

_____

_____

_____

_____

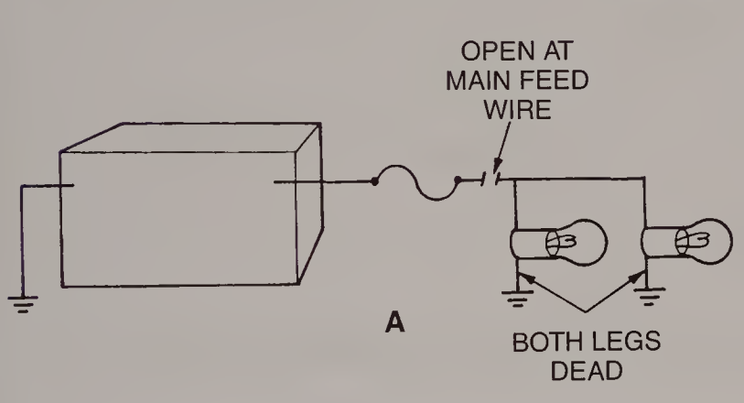
_____

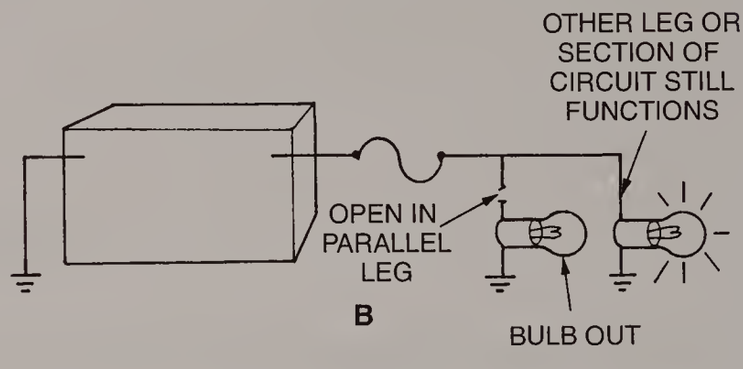
_____

_____

8. A(n) _____ problem is one that occurs under certain conditions. 8. _____

9. Look at the diagrams of open parallel circuits below. In each case, where would you start testing and why?





(A) _____

_____

_____

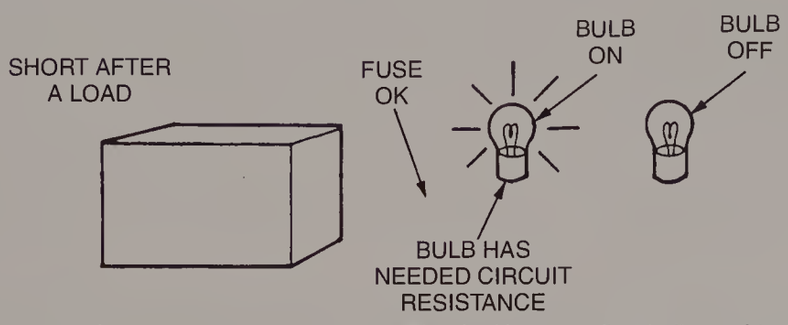
(B) _____

_____

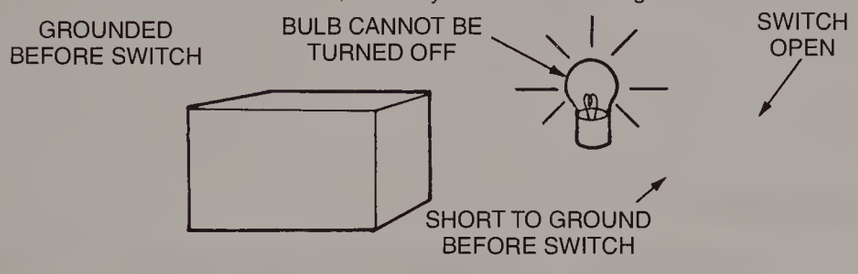
_____

10. A corroded or burned _____ terminal is the most common cause of high circuit resistance. 10. _____

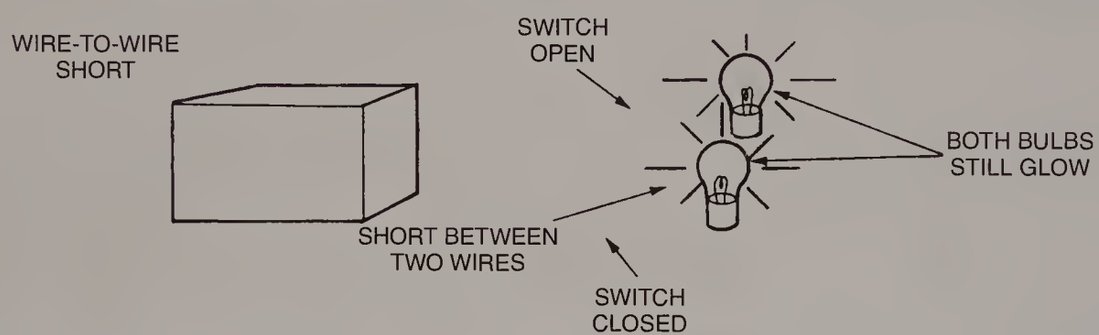
11. Look at the diagrams of short circuits below. In each case, draw the wiring described.



A – Short after a load. This short location would cut power to second bulb. However, first bulb would still work. Current blow would increase slightly because of less ohms in circuit. However, flow may not increase enough to blow fuse with resistance of one bulb still in circuit.



B – Short before a grounded switch. This would make load stay on all of the time, even with switch open. Current would bypass switch to ground.



C – Wire-to-wire short. This short would feed current across two legs. Even with one switch off, current would leak over to other leg. Only with both switches off would bulbs turn off.

Using Testing Devices

12. A(n) _____ wire should never be used to bypass a high resistance component, a fuse, or a circuit breaker. 12. _____

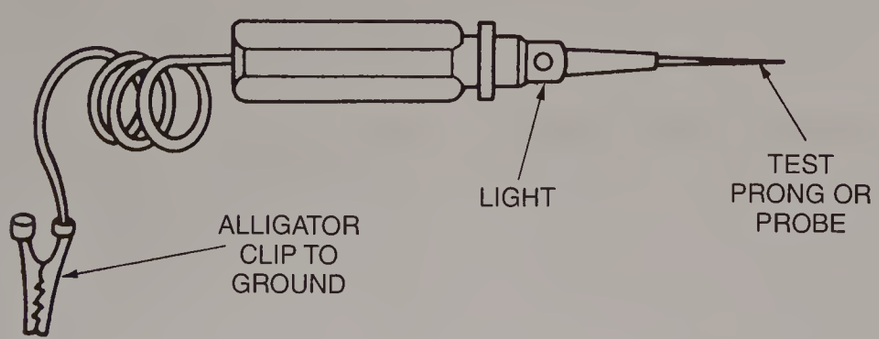
13. Identify the item below and describe its purpose.

Item: _____

Purpose: _____

_____

_____



Name _____

14. Explain why you should avoid using a test probe to puncture the insulation wires in a computer or sensor circuit.

_____

_____

_____

_____

_____

_____

_____

_____

15. How can a circuit breaker and compass be used to find shorts?

_____

_____

_____

_____

_____

_____

_____

_____

16. Name two testing devices used by an inductive circuit tracer to find shorts.

_____

_____

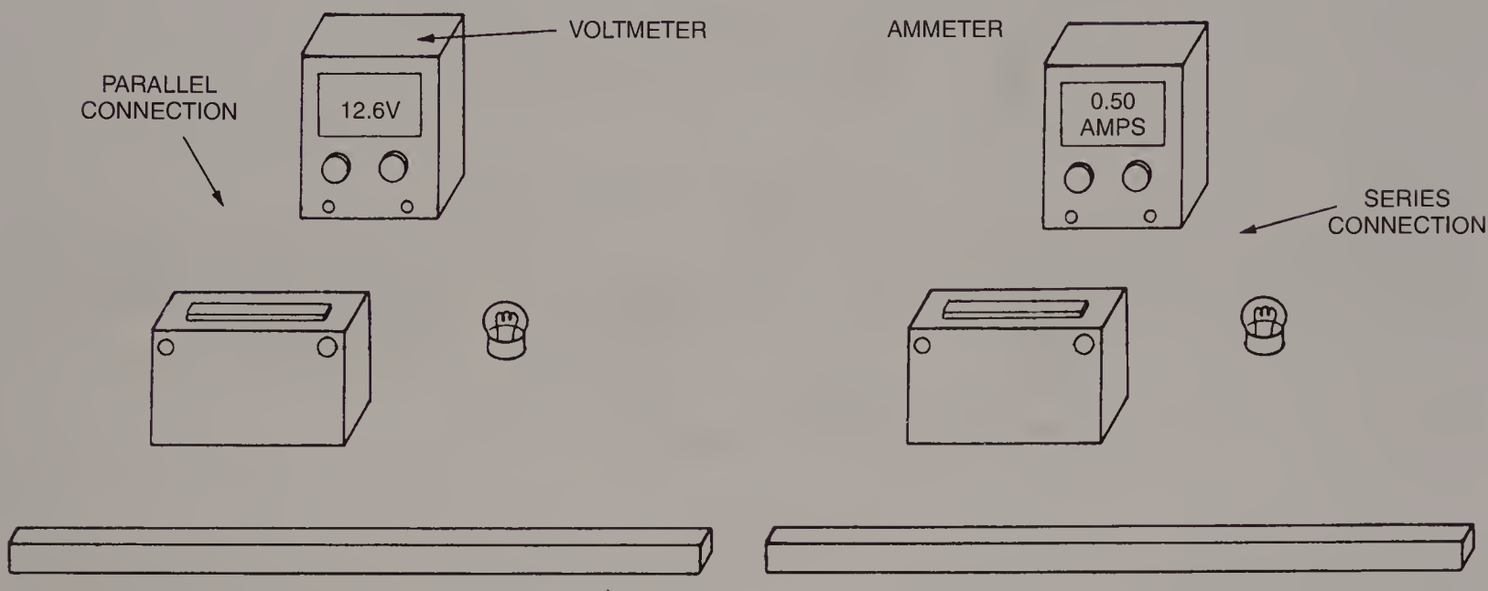
Using Multimeters

17. Name the two basic types of multimeters used in today's auto mechanics.

_____

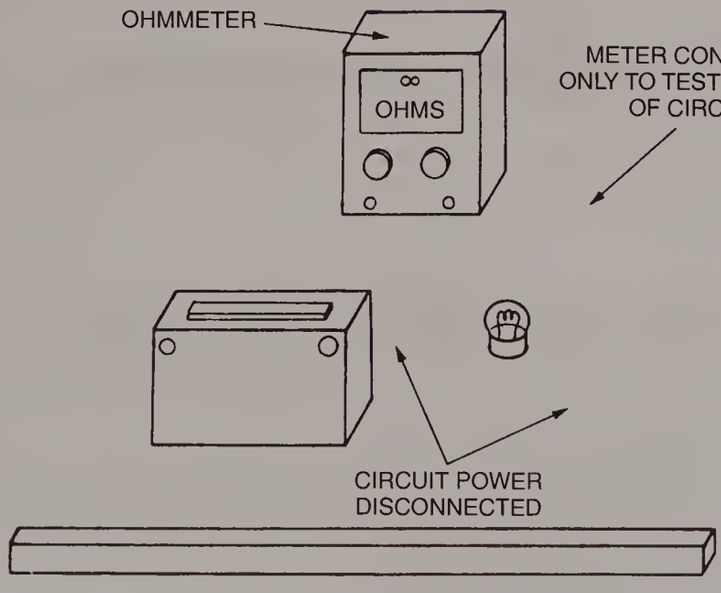
_____

18. On the diagram below, draw in the wires showing the methods normally used to connect a voltmeter, ammeter, and ohmmeter to a circuit.



A – Voltmeter is normally connected in parallel with circuit. Then it can measure the "electrical pressure" in the circuit.

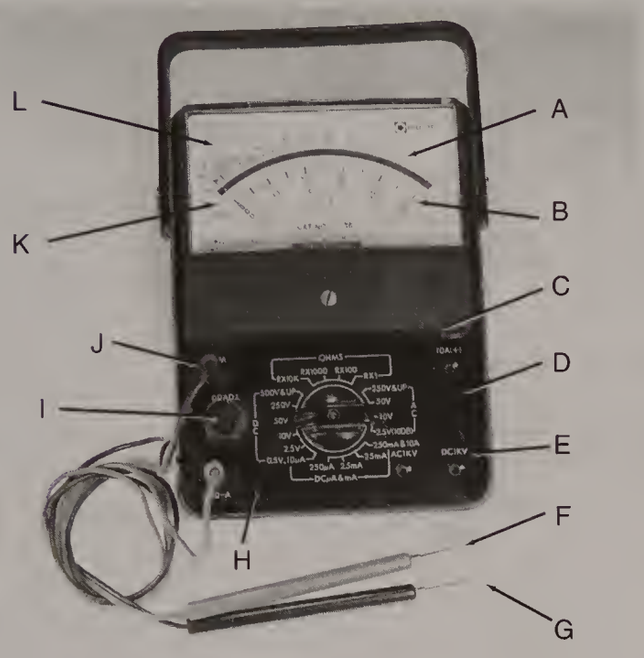
B – Conventional ammeter is wires in series with circuit. Then it can measure electron movement or current in circuit.



C – Ohmmeter must not be connected to circuit power. Power must be disconnected so that ohmmeter can use its battery power to measure resistance in ohms.

Name _____

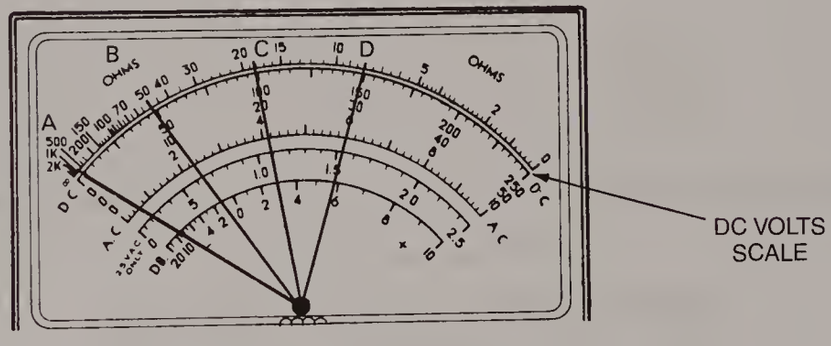
19. Identify the parts indicated on the analog multimeter below.



19. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

20. Read the analog voltmeter below, giving the voltage value at the following indicator positions below.

READING AN ANALOG VOLTMETER



Range Switch Position	Scale to Read
5 V	0–5 (50)
25 V	0–25 (250)
50 V	0–5 (50)
250 V	0–25 (250)
500 V	0–5 (50)

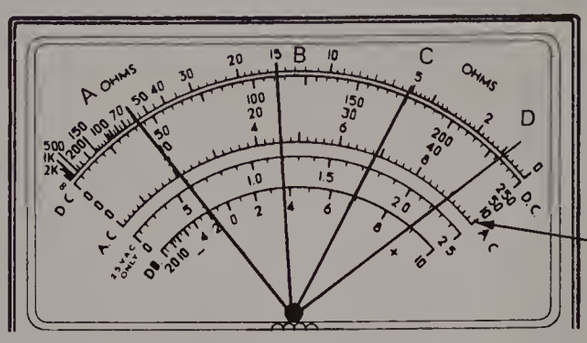
ANSWERS

Range Switch Position	Scale	Voltage Value at Indicator Position A	B	C	D
5 V	0–5	___	___	___	___
25 V	0–25	___	___	___	___
50 V	0–5	___	___	___	___

Abbreviation		Value	Symbol
1 MEGAVOLT	=	1 MILLION VOLTS (1,000,000 VOLTS)	(MV)
1 KILOVOLT	=	1 THOUSAND VOLTS (1,000 VOLTS)	(kV)
1 VOLT	=	1 VOLT	(V)
1 MILLIVOLT	=	1/1000 VOLT (.001 VOLT)	(mV)
1 MICROVOLT	=	1/1,000,000 VOLT (.000001 VOLT)	(μV)

21. Read the analog ammeter below, giving the current value at the following indicator positions.

READING AN ANALOG AMMETER



1 AMPERE = 1 AMPERE
1 MILLIAMPERE = 1/1000 AMPERE OR .001 AMPERE
1 MICROAMPERE = 1/1,000,000 or .000001 AMPERE

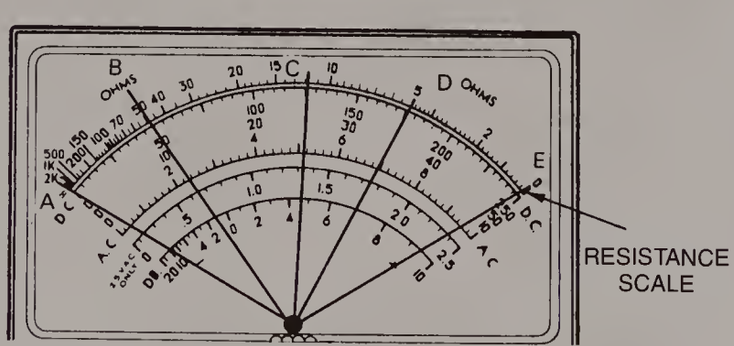
Range Switch Position	Scale Reads	Each Small Mark Equals
100 µA	0 to 100 µA	2 µA
10 mA	0 to 10 mA	.2 mA
100 mA	0 to 100 mA	2 mA
1000 mA	0 to 1000 mA	20 mA
10 A	0 to 10 A	.2 A

ANSWERS

Range Switch Position	Current Value at Indicator Position			
	A	B	C	D
100 µA	_____	_____	_____	_____
10 mA	_____	_____	_____	_____
100 mA	_____	_____	_____	_____
1000 mA	_____	_____	_____	_____
10 A	_____	_____	_____	_____

22. Read the analog ohmmeter below, giving the value in Ohms at the following indicator positions.

READING AN ANALOG OHMMETER



SCALE × 1 VALUE AS READ
SCALE × 10 MULTIPLY READING BY 10
SCALE × 1k MULTIPLY READING BY 1000
SCALE × 100k MULTIPLY READING BY 100,000

ANSWERS

Range Switch Position	Value in Ohms at Indicator Position				
	A	B	C	D	E
× 1	_____	_____	_____	_____	_____
× 10	_____	_____	_____	_____	_____
× 1k	_____	_____	_____	_____	_____
× 100k	_____	_____	_____	_____	_____

Name _____

23. A(n) _____ _____ measurement determines the internal resistance of a wire or component without disconnecting components as you would have to do with an ohmmeter. 23. _____

24. _____ _____ means that there is a perfect electrical path between the two test points. 24. _____

Rules for Using Multimeters

25. List 10 rules for using multimeters.

_____

_____

_____

_____

_____

_____

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_____

_____

_____

_____

_____

Basic Component Tests

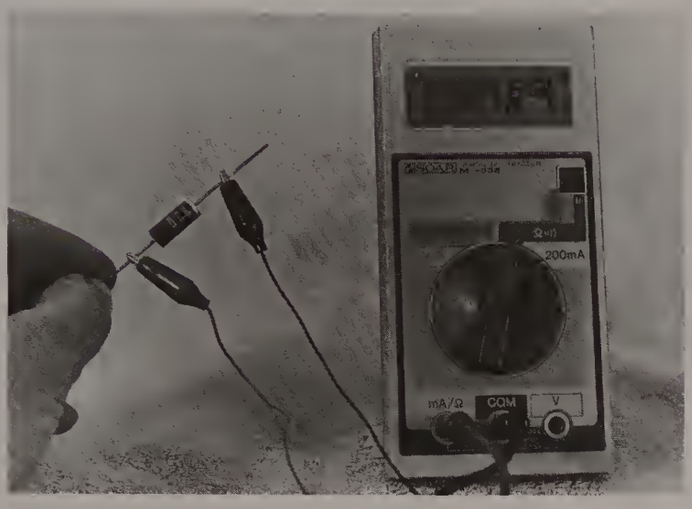
26. A(n) _____ (bad, good) connector will have little or no resistance across its terminals. 26. _____

27. A(n) _____ (bad, good) connector will have resistance that will lower current flow through the connector. 27. _____

28. Which of the following can be used to check a connector? 28. _____

(A) Test light.
(B) Voltmeter.
(C) Ohmmeter.
(D) All of the above.

29. What is being done in the photo below? 29. _____



30. When testing a switch, _____ should be zero when closed and infinite when open. 30. _____

31. A face can quickly be checked with a(n) _____ _____. 31. _____

32. A(n) _____ _____ will usually give ohms specs for different variable resistor positions. 32. _____

33. If tests show different values, the variable resistor is _____ (bad, good). 33. _____

34. A(n) _____ switch will change its internal resistance with a change in a condition. 34. _____

35. Why should you always ground the lead on a condenser before using it?

_____

_____

36. A(n) _____ is normally used to check diodes. 36. _____

37. Most _____ in complex circuits require the expertise of a specialized circuit technician. 37. _____

38. Describe how each of the following can be used when doing electrical tests and repairs.

Contact cleaner: _____

_____

_____

Freeze spray: _____

_____

_____

Electrical solvent: _____

_____

_____

Name _____

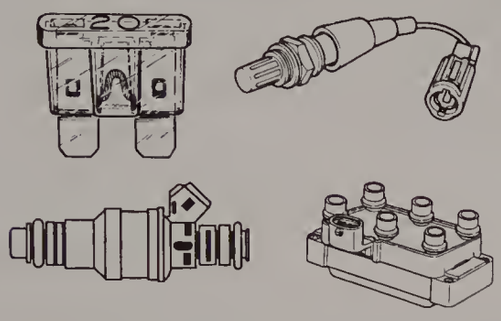
Date _____

Instructor _____

Score _____ Text pages 159–166

Chapter 10

Review of Safety



After studying this chapter and completing supplemental exercises, you will be able to:

- List the types of accidents that can happen when doing electrical repairs.
- Summarize the dangers that are present on and around an automobile.
- Develop a safe work attitude.
- Describe general safety rules.
- Prevent shop accidents.
- Summarize what to do in case of an accident.

Instructions: As you study Chapter 10 of the text, complete the following workbook problems in the spaces provided.

Electric Shock

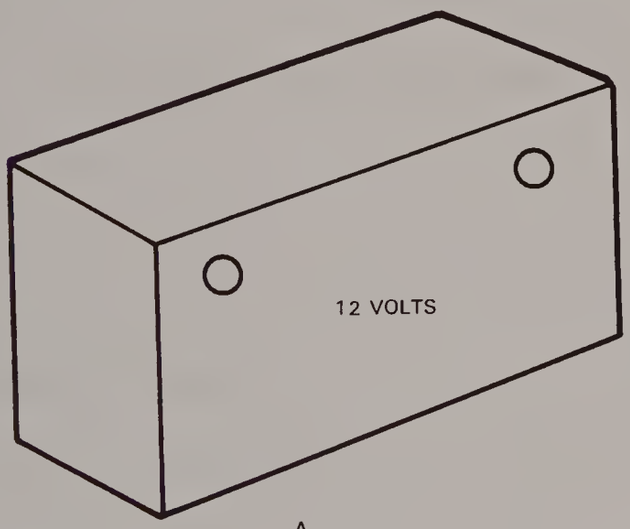
1. Identify the various sources of voltage in an auto shop.

1. (A) _____

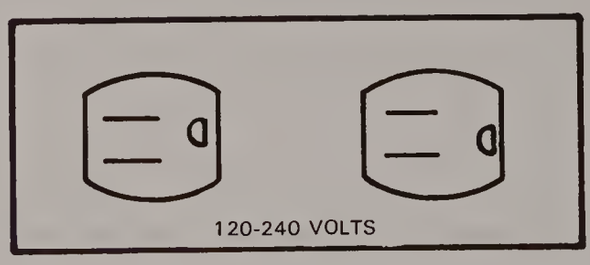
(B) _____

(C) _____

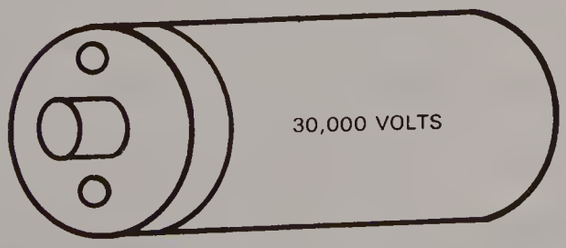
(D) _____



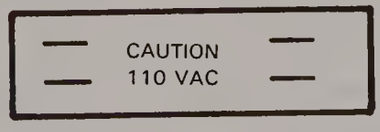
A



C



B



D

2. Some cars are equipped with a circuit that converts alternator output into 110 volts AC that can produce a current flow through your body that can cause _____. 2. _____

3. Explain why the ground prong should never be removed from equipment cords.

_____

_____

_____

_____

4. Why should you never use electrical equipment on a wet shop floor?

_____

_____

_____

5. Why should electrical cords be kept in good condition?

_____

_____

6. What could happen if you touched the "hot" conductors in a broken lightbulb?

_____

7. Why should you NEVER place a drop light where it could be splashed with coolant or other liquid?

_____

_____

_____

_____

_____

_____

8. Why should you respect wall outlet electricity?

_____

_____

_____

_____

9. Some people are more _____ to electric shock than others. 9. _____

10. Discharge condensers by grounding their _____ before handling them. 10. _____

11. Electrical burns are caused by the _____ from electricity. 11. _____

Name _____

12. Which of the following is safe to wear when working on a car? 12. _____

(A) A ring.

(B) A necklace.

(C) A watch.

(D) None of the above.

Electrical Fires

13. An electrical fire is the result of excess _____ heating and burning wire insulation. 13. _____

14. List six steps you can take to prevent electrical fires.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Battery Dangers

15. Battery _____ can happen when a flame or spark ignites hydrogen gas that can hover over the top of a battery case. 15. _____

16. List four ways to prevent battery explosions.

_____

_____

_____

_____

_____

_____

_____

17. Which of the following should NOT be done when working with car batteries? 17. _____

(A) Use a battery strap or carrier to remove and install car batteries.

(B) Wear eye protection.

(C) Lay tools on top of a battery.

(D) Disconnect the battery cables before charging a dead battery.

Gasoline Dangers

18. Which of the following statements describes a safe practice when working around gasoline? 18. _____

(A) Use gasoline as a cleaning agent.

(B) Spread "quick dry" (oil absorbent) on gasoline spills.

(C) Keep sources of heat (soldering gun or torch) away from the engine's fuel system.

(D) Leave the car battery connected when disconnecting a fuel line on an engine.

In Case of a Fire

19. In the event of a fire in the shop, list six steps you should take.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____

20. Look at the chart below and answer the following questions.

(A) What type of extinguisher should be used on an electrical equipment fire?

_____

(B) What type of extinguisher could be used to extinguish Class A, B, and C fires?

_____

(C) Describe how to use a dry chemical fire extinguisher.

_____

_____

_____

_____

KIND OF FIRE

DECIDE THE CLASS OF FIRE YOU ARE FIGHTING. . .

. . .THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS

APPROVED TYPE OF EXTINGUISHER

MATCH UP PROPER EXTINGUISHER WITH CLASS OF FIRE SHOWN AT LEFT

FOAM Solution of Aluminum Sulphate and Bicarbonate of Soda	CARBON DIOXIDE Carbon Dioxide Gas Under Pressure	SODA ACID Bicarbonate of Soda Solution and Sulphuric Acid	PUMP TANK Plain Water	GAS CARTRIDGE Water Expelled by Carbon Dioxide Gas	MULTI-PURPOSE DRY CHEMICAL	ORDINARY DRY CHEMICAL
CLASS A FIRES — USE THESE EXTINGUISHERS — ORDINARY COMBUSTIBLES • WOOD • PAPER • CLOTH ETC.						
CLASS B FIRES — USE THESE EXTINGUISHERS — FLAMMABLE LIQUIDS, GREASE • GASOLINE • PAINTS • OILS, ETC.						
CLASS C FIRES — USE THESE EXTINGUISHERS — ELECTRICAL EQUIPMENT • MOTORS • SWITCHES ETC.						

HOW TO OPERATE

FOAM: Don't Play Stream into the Burning Liquid. Allow Foam to Fall Lightly on Fire.

CARBON DIOXIDE: Direct Discharge as Close to Fire as Possible. First at Edge of Flames and Gradually Forward and Upward

SODA-ACID, GAS CARTRIDGE: Direct Stream at Base of Flame

PUMP TANK: Place Foot on Footrest and Direct Stream at Base of Flames

DRY CHEMICAL: Direct at the Base of the Flames. In the Case of Class A Fires, Follow Up by Directing the Dry Chemicals at Remaining Material That is Burning

Other Shop Dangers

21. Identify the protection devices shown below.

21. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

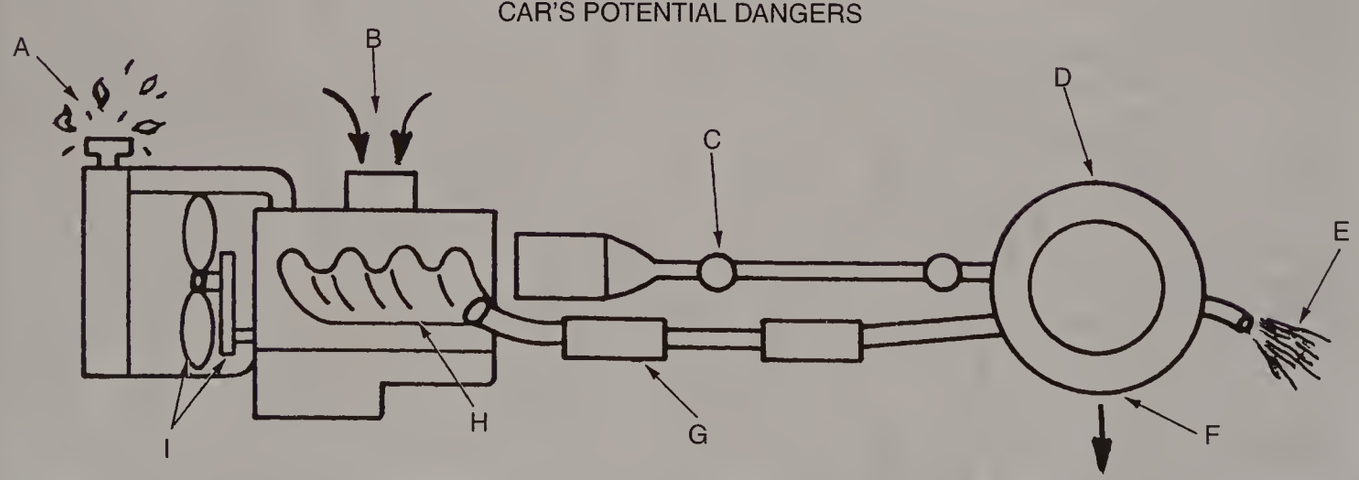
Basic Safety Rules

22. Wear eye protection when:
    (A) operating power tools.
    (B) working around a spinning engine fan.
    (C) carrying batteries.
    (D) All of the above.

22. _____

23. Identify the potential dangers on the automobile diagram shown below.

CAR'S POTENTIAL DANGERS



23. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____

Name _____

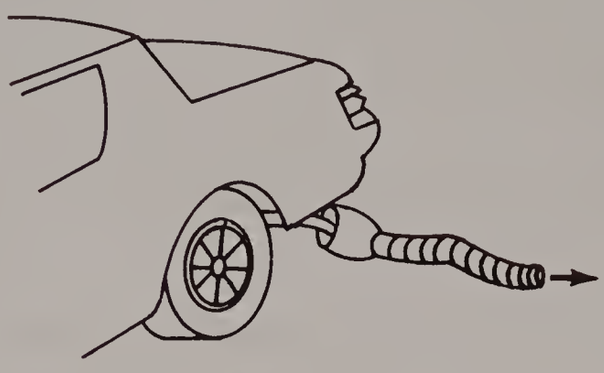
24. What has been done in the diagram below and why?

_____

_____

_____

_____



25. Read the following statements. If a statement describes a safe practice, place an **S** in the blank. If a statement describes an unsafe practice, place a **U** in the blank.

(A) Avoid anyone who does not take shop work seriously. _____

(B) Leave tools, creeper, or parts on the floor. _____

(C) Roll up long sleeves and secure long hair when working on a car. _____

(D) Never carry shop tools or parts in your pockets. _____

(E) Wear full face protection when welding. _____

(F) Use the right tool for the job. _____

(G) Remove equipment guards or shields. _____

(H) Lift with your back, not your legs. _____

(I) Use adequate lighting. _____

(J) Ventilate the work area when needed. _____

(K) Use compressed air to blow asbestos dust from parts. _____

(L) Work under a car held by a floor jack. _____

(M) Drive slowly when in the shop area. _____

(N) When a car engine is running, make sure that the transmission or transaxle is in park. _____

(O) Do not smoke. _____

(P) Avoid contact with lead. _____

Name _____

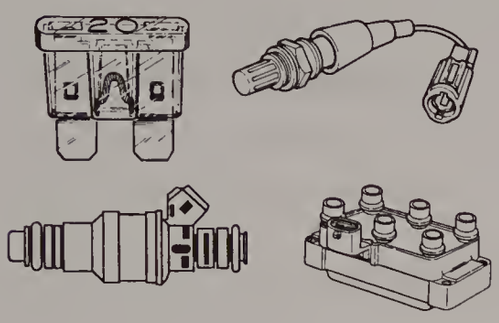
Date _____

Instructor _____

Score _____ Text pages 167–198

Chapter 11

Computers, Sensors, Actuators



After studying this chapter and completing supplemental exercises, you will be able to:

- Compare a computer system to the human nervous system.
- Describe the input, processing, and output sections of a basic computer system.
- Explain sensor classifications.
- Explain actuator classifications.
- Sketch a block diagram of a fundamental computer network.
- Summarize where computers, control modules, sensors, and actuators are typically located.
- Explain the basic parts of a computer.
- Summarize the flow of data through a computer.
- Explain how a computer uses sensor inputs to determine correct outputs for actuators.
- Describe the operation of vehicle sensors.
- Explain the operation of vehicle actuators.

Instructions: As you study Chapter 11 of the text, complete the following workbook problems in the spaces provided.

Cybernetics

1. The term *cybernetics* refers to the study of how electrical-mechanical mechanisms can duplicate the actions of the _____ _____. 1. _____

2. In comparing the human nervous system with a computer system, list the human senses or actions that would be comparable to the vehicle sensors and actuators given below.

COMPUTER SYSTEM INPUT	HUMAN NERVOUS SYSTEM
KNOCK SENSOR INPUT	_____
OXYGEN SENSOR INPUT	_____
LIGHT DIMMING PHOTO CELL INPUT	_____
PRESSURE SENSOR INPUT	_____
LOW OIL LEVEL SENSOR INPUT	_____
SOLENOID, RELAY, OR SERVO MOTOR OUTPUT	_____
DASH GRAPHIC DISPLAY OUTPUT	_____
MEMORY AND PROCESSOR IC CIRCUITS IN COMPUTER	_____

- Match each of the following descriptions to their appropriate terms.

3. Nervous system (input). _____ (A) Computer
4. Brain (processing). _____ (B) Sensor
5. Reflex action (output). _____ (C) Actuator

Hardware and Software

6. Briefly explain the difference between computer hardware and computer software.

_____

_____

_____

Computer Advantages

7. List nine advantages of using computers in modern automobiles.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Computer Action

8. List in sequence the three stages of computer operation.

_____

_____

_____

9. Describe each of the following major sensor or input classifications.

Variable resistor type sensor: _____

_____

Potentiometer type sensor: _____

_____

Name _____

Switching type sensor: _____

_____

Voltage generator type sensor: _____

_____

Magnetic type sensor: _____

10. Describe each of the following actuator or output classifications below.

Solenoid type output: _____

_____

Relay type output: _____

_____

Servo motor type output: _____

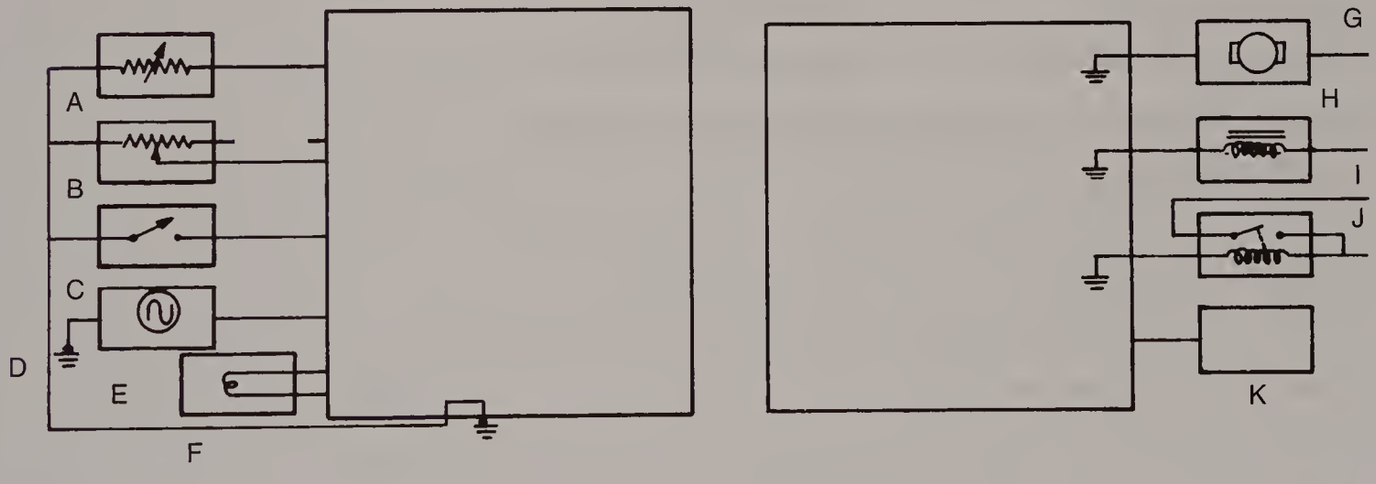
_____

Display type output: _____

_____

Control module output: _____

11. Identify the vehicle sensor categories and actuator classifications below.



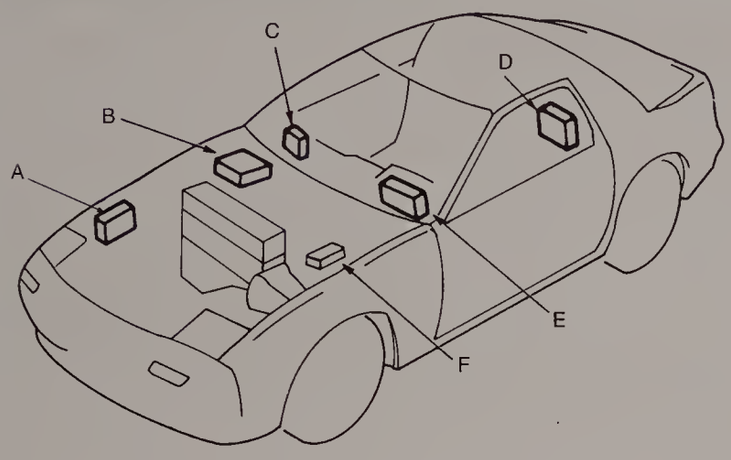
11. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

(G) _____
(H) _____
(I) _____
(J) _____
(K) _____

12. A simple drawing that shows how the sensors, actuators, and computer interact is a(n) _____ _____ _____. 12. _____

Computer Locations, Names, and Types

13. Name the potential locations of computers in an automobile. 13. (A) _____



(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

14. Any electronic circuit configuration that can use multiple inputs to find outputs is a(n) _____. 14. _____

15. Which of the following can be another name for a computer? 15. _____

(A) Microprocessor. (C) Logic module.
(B) Electronic control unit. (D) All of the above.

16. Describe the purpose of each of the following types of computers.

Vehicle control module: _____

_____

Engine control module: _____

_____

Power train control module: _____

_____

Instrumentation module: _____

_____

Anti-lock brake module: _____

_____

Ignition control module: _____

_____

Suspension system module: _____

_____

Climate control module: _____

_____

Name _____

Integrated Computer System (Multiplexing)

17. In an integrated computer system, computers exchange data from sensors to prevent _____ of parts and to reduce wiring. 17. _____

Vehicle Sensor Operation

18. Describe the purpose of each of the following common vehicle sensors.

Intake air temperature sensor: _____

Engine coolant temperature sensor: _____

Oxygen sensor: _____

Manifold absolute pressure sensor: _____

Barometric pressure sensor: _____

Throttle position sensor: _____

Engine speed sensor: _____

Crank position sensor: _____

Airflow sensor: _____

Knock sensor: _____

Transaxle/transmission sensor: _____

Brake sensor: _____

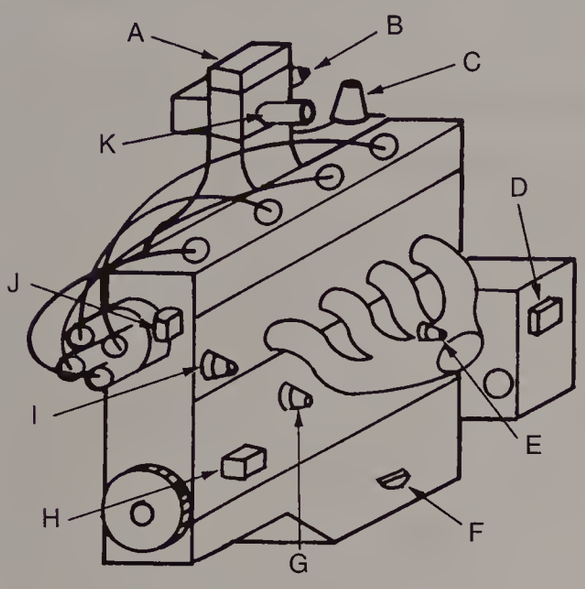
Camshaft position sensor: _____

Oil level sensor: _____

EGR position sensor: _____

Impact sensor: _____

19. Identify the sensors on the diagram below.



19. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____

20. A(n) _____ (active, passive) sensor is one that generates its own voltage signal. 20. _____

21. A(n) _____ (active, passive) sensor depends on an external source of voltage to return a signal to the computer. 21. _____

22. The reference voltage, abbreviated Vref, is typically around _____ volts. 22. _____

23. The voltage output of the oxygen sensor varies with changes in the oxygen content of the _____. 23. _____

24. Most heated O_2 sensors are also called _____ _____ sensors because of their active materials. 24. _____

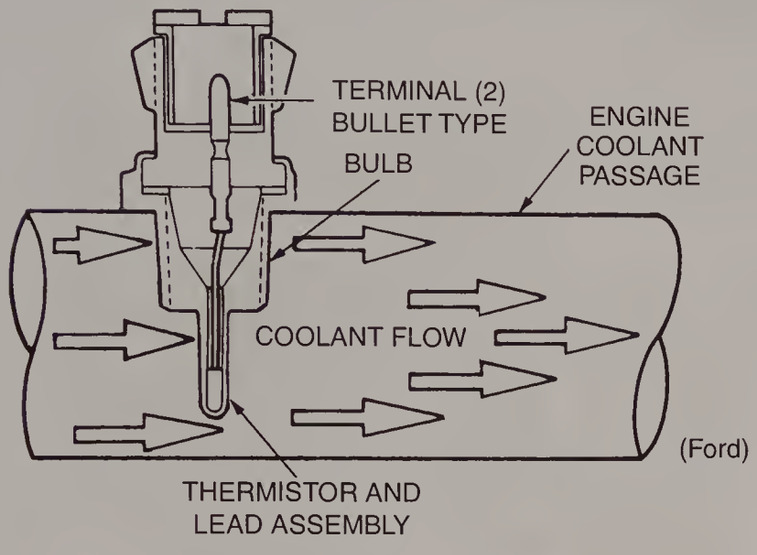
25. After the engine warms to operating temperature, the system changes to a(n) _____ (closed, open) loop operating mode, using feedback from sensors to control the system. 25. _____

26. The intake air temperature sensor helps the computer compensate for changes in outside air temperature and maintain an almost perfect _____ - _____ _____ . 26. _____

Name _____

27. What type of sensor is shown in the diagram below?

_____



(Ford)

28. The throttle position sensor provides data input on the _____ output of the engine. 28. _____

29. As engine speed and airflow _____ (decrease, increase), air forces the flap on the flap airflow sensor to swing open. 29. _____

30. A mass airflow sensor is desirable because it will automatically compensate for: 30. _____

(A) air temperature.

(B) atmospheric pressure.

(C) humidity.

(D) All of the above.

31. The camshaft position sensor monitors the _____ of the engine camshaft. 31. _____

32. List the three basic types of MAP sensors.

_____

_____

_____

33. When the knock sensor detects knock, an electrical signal allows the computer to retard the ignition timing or lower turbocharge boost enough to prevent _____ damage. 33. _____

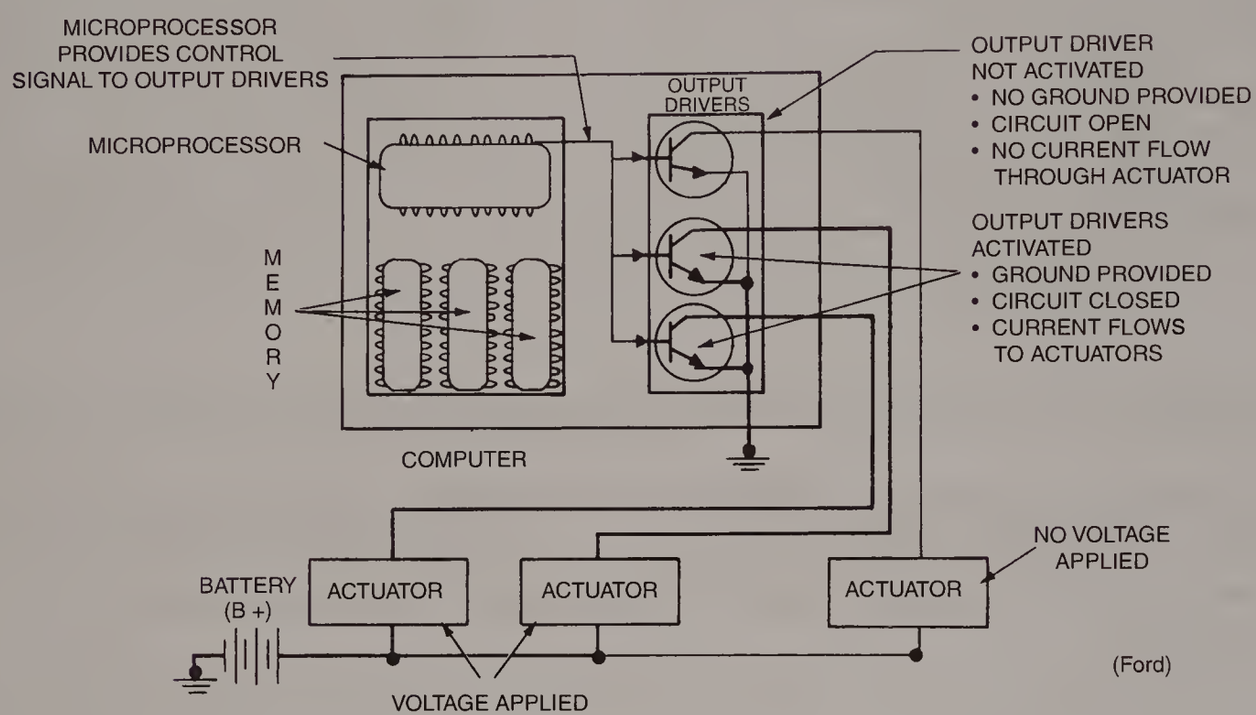
34. The low _____ _____ _____ allows the computer to activate a dash warning light or even "kill" the engine when oil is below a specific point. 34. _____

35. The vehicle speed sensor produces a _____ (high, low) frequency signal when the car is moving slowly. 35. _____

36. A _____ (higher, lower) frequency signal is produced by the vehicle speed sensor when the car is moving with more speed. 36. _____

Actuator Operation

37. On the diagram below, use arrows to indicate the circuit path from the actuators to the computer.



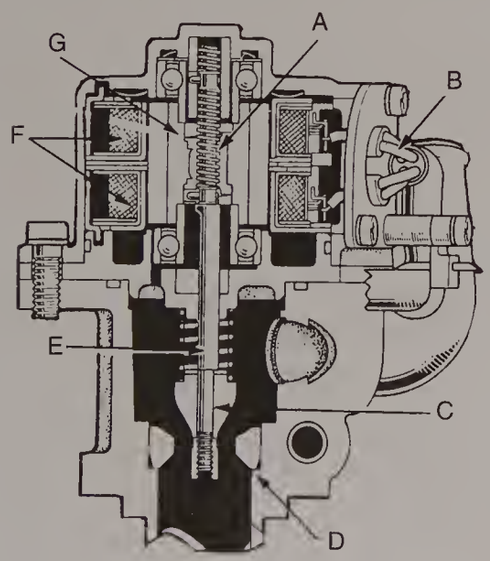
(Ford)

38. A(n) _____ actuator can be used to operate a vacuum switch. 38. _____

39. A(n) _____ can serve as a good actuator when a high current load must be controlled by the computer. 39. _____

40. Identify the parts indicated on this motor type actuator.

40. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

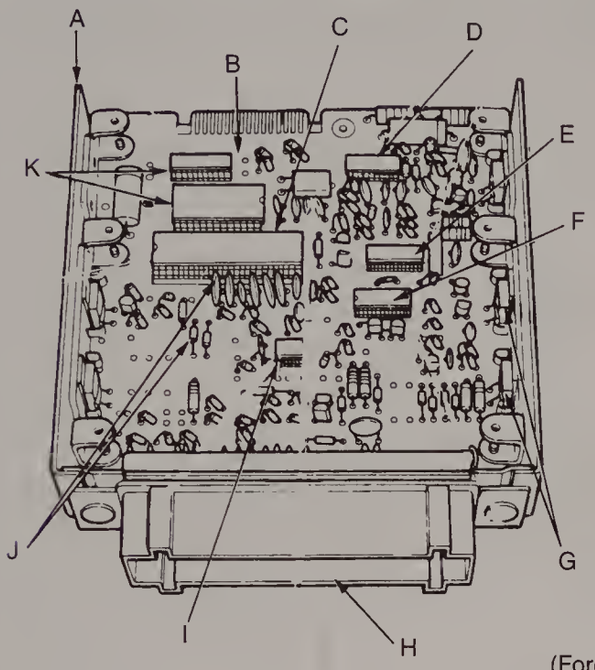


(Toyota)

Name _____

Computer Operation

41. Identify the basic parts indicated on the diagram of the computer below.



(Ford)

41. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____

42. Describe the purpose of each of the following parts of a computer listed below.

Voltage regulator: _____

_____

Amplifiers: _____

_____

Conditioners: _____

_____

Microprocessor: _____

_____

Memory: _____

_____

Clock: _____

_____

Output drivers: _____

_____

Circuit boards: _____

_____

Harness connector: _____

_____

Computer housing: _____

_____

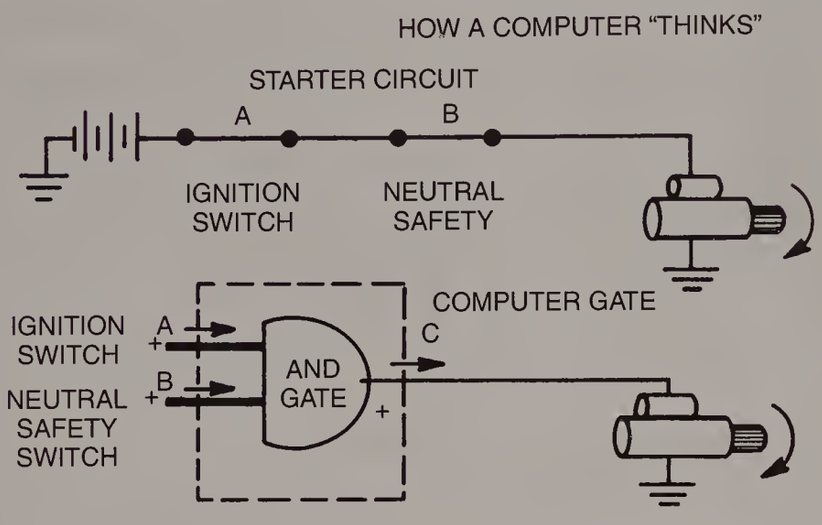
43. A computer _____ simply strengthens various signals when inside the computer. 43. _____

44. A(n) _____ conditioner is needed to change analog signals into digital signals. 44. _____

45. List two purposes of a buffer. _____

_____

46. Study the diagram below. Then complete the truth table under Column C, indicating whether or not the motor is on or off.

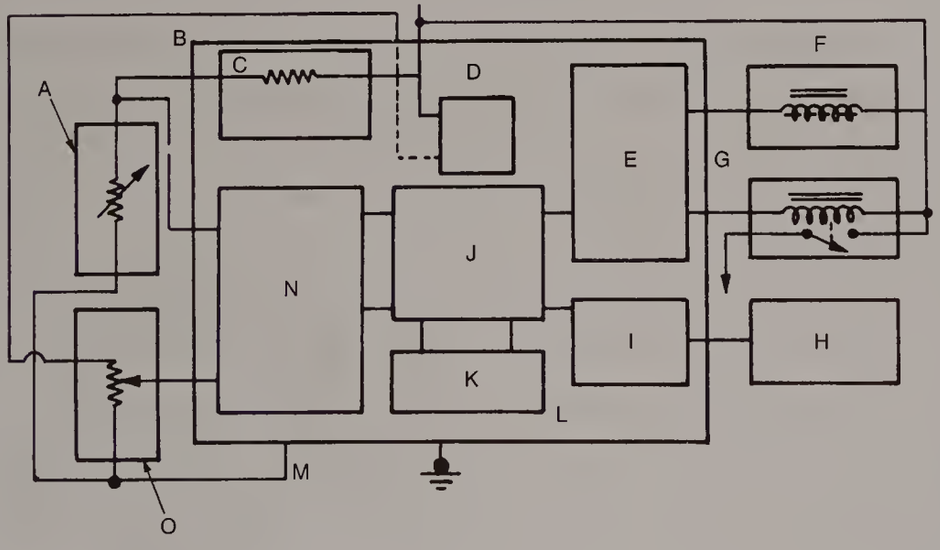


TRUTH TABLE

A	B	C	
O	O	O	_____
O	I	O	_____
I	O	O	_____
I	I	I	_____

0 = NO VOLTAGE
1 = VOLTAGE

47. Identify the items indicated on the block diagram of the computer system below.



47. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____

Name _____

48. A memory rating is an indication of a chip's ability to _____ _____ . 48. _____

49. _____ -_____ memory does not store data permanently. 49. _____

50. The abbreviations for the four basic types of computer memory are listed below. Name them and describe their functions.

RAM: _____

_____

_____

_____

ROM: _____

_____

_____

_____

PROM: _____

_____

_____

_____

EPROM: _____

_____

_____

_____

KAM: _____

_____

_____

_____

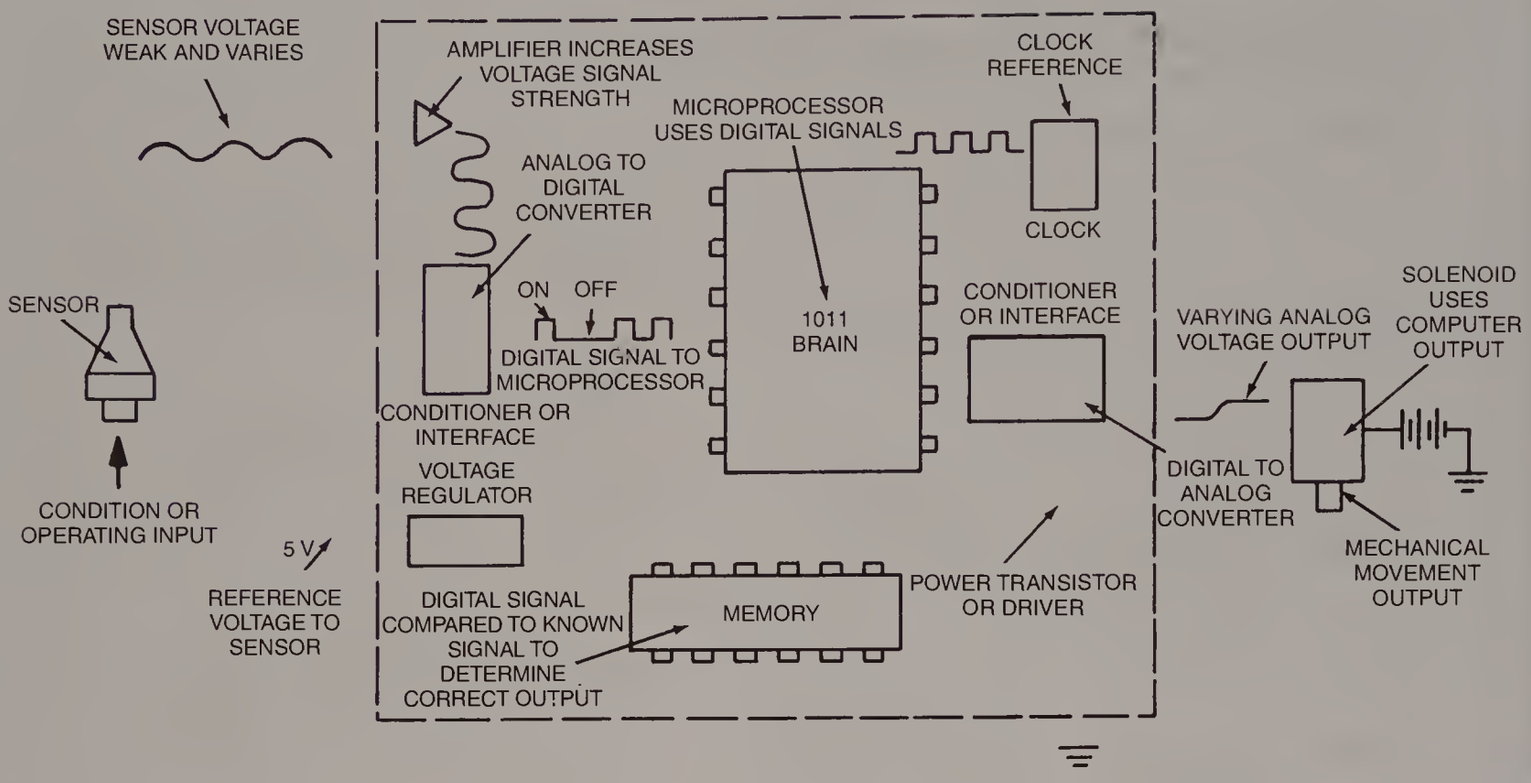
51. The term _____ -_____ _____ refers to how these two sections of a computer communicate or exchange data. 51. _____

52. A memory address will store data as _____ numbers at specific pins or locations in the memory chips of a computer. 52. _____

53. A microprocessor will compare an input binary number with a known correct binary number in _____. 53. _____

54. The microprocessor can then determine what _____ is needed. 54. _____

55. Using arrows or a colored pencil, trace the flow of data through this simplified computer system.



56. A computer can be classified by the amount of _____ it can process. 56. _____

Name _____

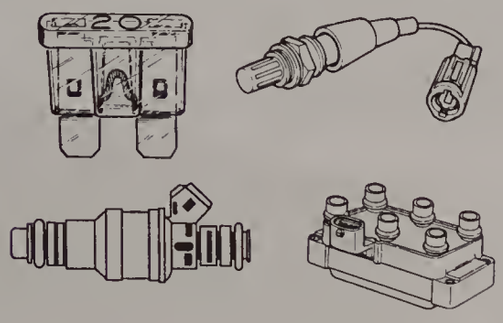
Date _____

Instructor _____

Score _____ Text pages 199–210

Chapter 12

Batteries



After studying this chapter and completing supplemental exercises, you will be able to:

- Summarize the construction of an automotive battery.
- Explain the major parts of a car battery.
- Describe the operation of an auto battery.
- Give the voltage output from one or more battery cells.
- Compare battery terminal types.
- Explain typical battery ratings.
- Read a built-in hydrometer.
- Sketch the routing of battery cables.
- Summarize how a battery is mounted in a car.

Instructions: As you study Chapter 12 of the text, complete the following workbook problems in the spaces provided.

Battery Operation

1. A battery is: 1. _____
   (A) a chemical device.
   (B) an electrical device.
   (C) a chemical-electrical device.
   (D) None of the above.
2. Battery _____ refers to when current is flowing out of the battery. 2. _____
3. Battery _____ refers to when current is flowing back into the battery. 3. _____
4. List and describe the four basic parts of a battery cell.

_____

_____

_____

_____

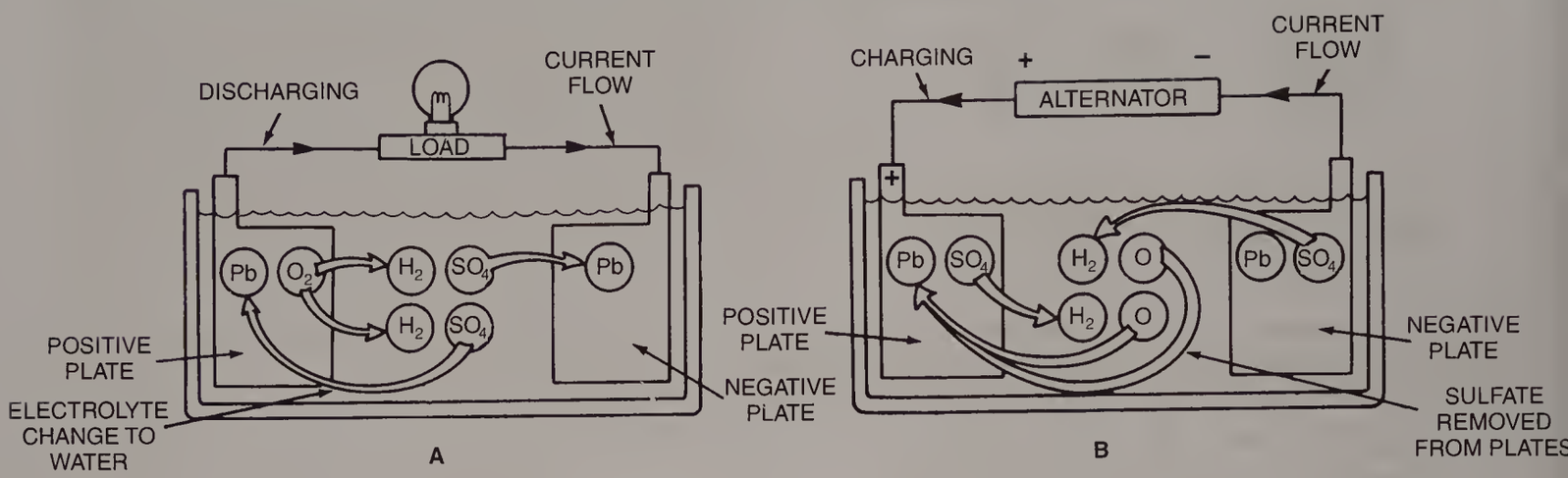
_____

_____

_____

_____

5. Look at the diagram below. Describe what is happening in each one.



(A) _____

_____

(B) _____

_____

Battery Functions

6. List five important functions of an auto battery.

_____

_____

_____

_____

_____

Battery Construction

7. A battery element is made up of: 7. _____

   (A) positive plates.

   (B) negative plates.

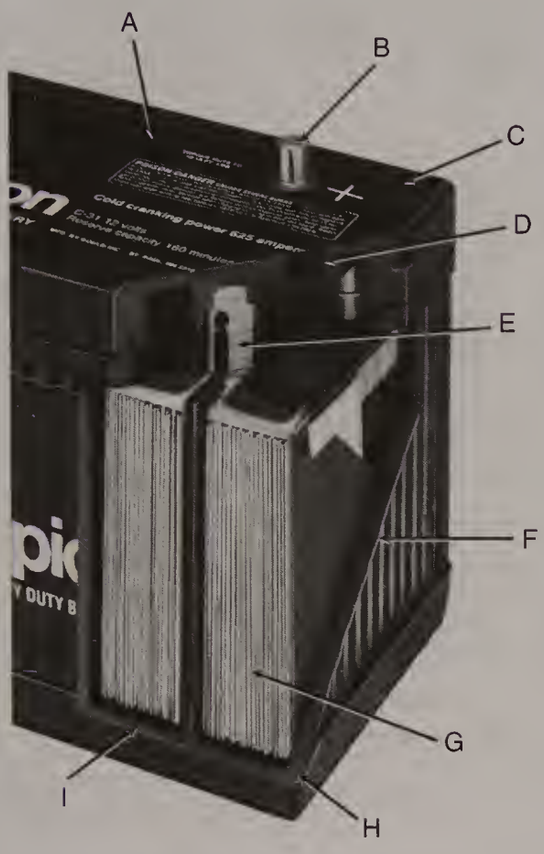
   (C) straps and separators.

   (D) All of the above.

8. Battery _____ are made of a grid coated with porous lead. 8. _____

Name _____

9. Identify the parts indicated on the battery below.



9. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____

10. Explain why electrolyte must never come in contact with your skin or eyes.

_____

_____

11. A means of connecting the battery plates to the car's electrical system is provided by the _____ _____. 11. _____

Battery Cables

12. The _____ (negative, positive) battery cable is normally red and fastens to the starter solenoid. 12. _____

13. The _____ (negative, positive) battery cable is usually black and connects to the ground on the engine block. 13. _____

14. A battery cable _____ _____ allows other wires to make electrical contact with the positive battery cable. 14. _____

15. When two batteries are connected in _____ , their output voltage doubles. 15. _____

Wet- and Dry-Charged Batteries

16. A wet-charged battery is filled with _____ and is charged at the factory. 16. _____

Maintenance-Free Battery

17. A maintenance-free battery is easily identified because it does not use removable _____ caps. 17. _____

18. In maintenance-free batteries, since _____ is used to make the battery plates, gassing and loss of electrolyte is reduced. 18. _____

Battery Ratings

19. Name and describe two types of battery ratings.

_____

_____

_____

_____

_____

_____

20. A(n) _____ rating is the equivalent of the cold cranking rating and measures how well the battery can crank an engine when at 0°F (-18°C). 20. _____

Battery Temperature and Efficiency

21. As battery temperature drops, battery power is _____ (decreased, increased). 21. _____

Name _____

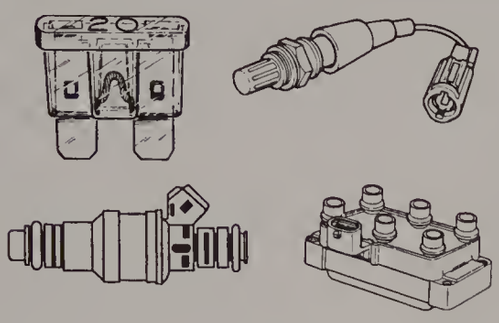
Date _____

Instructor _____

Score _____ Text pages 211–226

Chapter 13

Starting Systems



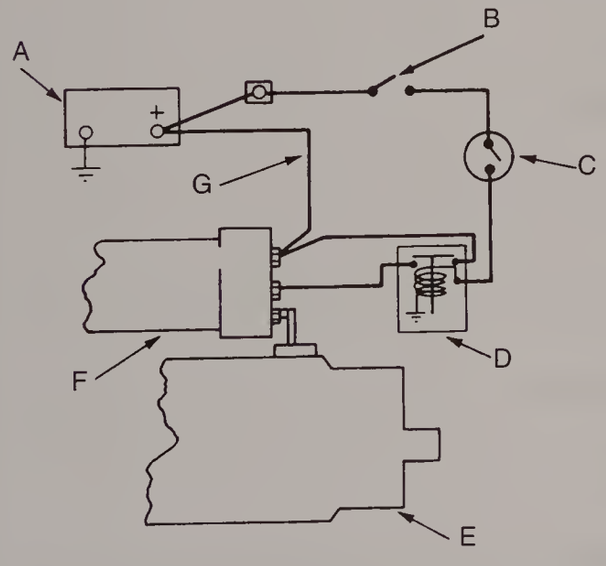
After studying this chapter and completing supplemental exercises, you will be able to:

- List the major parts of a starting system.
- Describe the operation of a starting system.
- Summarize the construction and operation of a starting motor.
- Explain the construction of a starter solenoid and relay.
- Describe the action of a starter drive mechanism.
- Compare field coil and permanent magnet type starting motors.
- Summarize the operation of a neutral safety switch.
- Sketch a basic starting circuit.

Instructions: As you study Chapter 13 of the text, complete the following workbook problems in the spaces provided.

Major Starting System Parts

1. Identify the parts indicated on the starting circuit below.



(General Motors)

1. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

2. The major parts of a starting system are listed below. Describe their purposes.

Battery: _____

_____

Ignition switch: _____

_____

Neutral safety switch: _____

_____

Starter solenoid: _____

_____

Cranking motor: _____

_____

Starting Motor Operation

3. The starting motor, also called the cranking motor, changes the electrical energy from the battery into _____ (electrical, mechanical) energy to spin the engine crankshaft. 3. _____

4. This serves as a sliding electrical connection between the motor windings and the brushes. 4. _____

   (A) Brush.

   (B) Loop.

   (C) Commutator.

   (D) None of the above.

5. Battery current is carried to the spinning windings by the _____. 5. _____

6. A metal framework with several sets of windings (loops) wrapped around it is the _____ _____. 6. _____

7. The stationary magnetic flux around the armature is the _____ _____ _____. 7. _____

8. Insulated wires wrapped around iron cores are _____ _____ in a starting motor. 8. _____

9. Some new starting motors use only permanent _____ to produce a stationary field. 9. _____

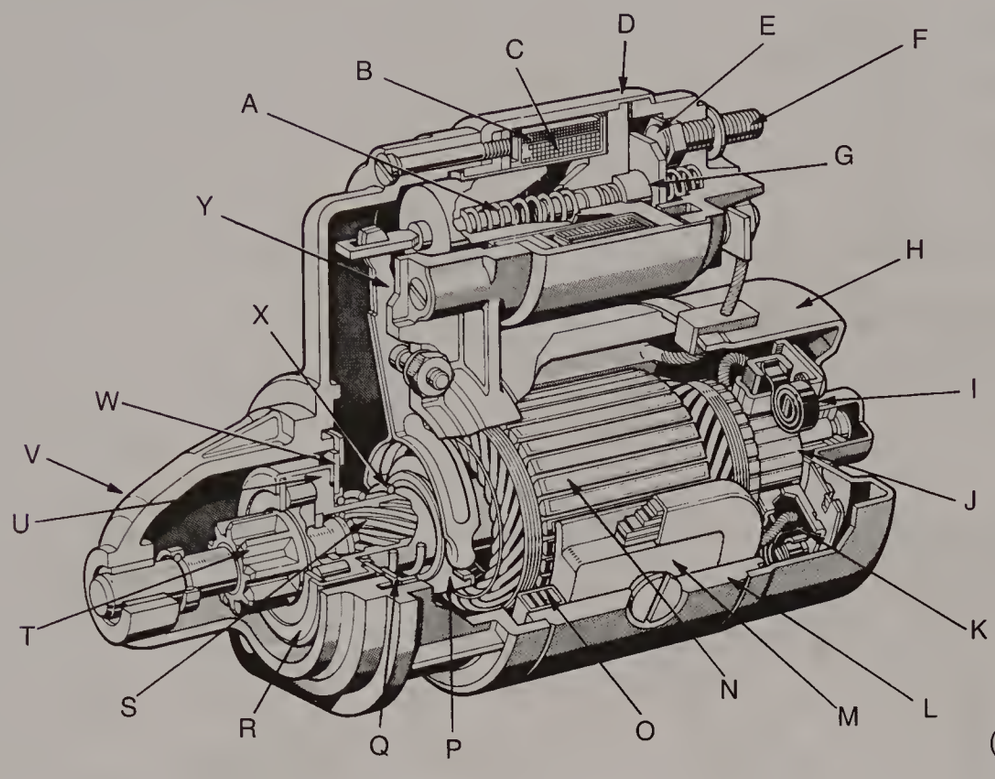
Starter Frames

10. The _____ _____ or field frame is the large steel cylinder that holds the field coils and/or field magnets. 10. _____

11. The housing around the starting motor drive gear is the _____ _____ _____. 11. _____

Name _____

12. Identify the parts indicated on the diagram of the starting motor below.



(Robert Bosch)

12. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____

13. The brushes and springs around the armature commutator are usually held by the _____ _____ _____.

13. _____

14. The pinion gear is locked in one direction and released in the other by the:

    (A) starter pinion gear.

    (B) starter overrunning clutch.

    (C) positive engagement starter.

    (D) None of the above.

14. _____

15. The small gear on the overrunning clutch is a(n) _____.

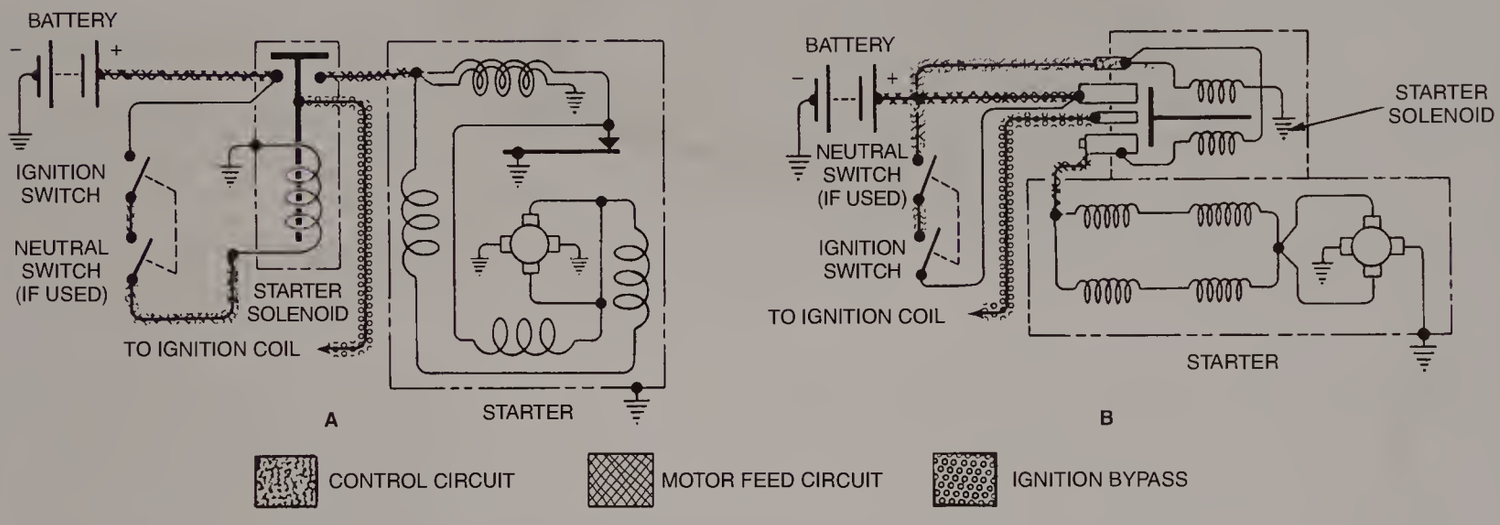
15. _____

Starting Motor Classifications

16. Identify the two types of starting motors diagrammed below.

16. (A) _____

    (B) _____



17. List the three types of internal connections in direct current electric motors.

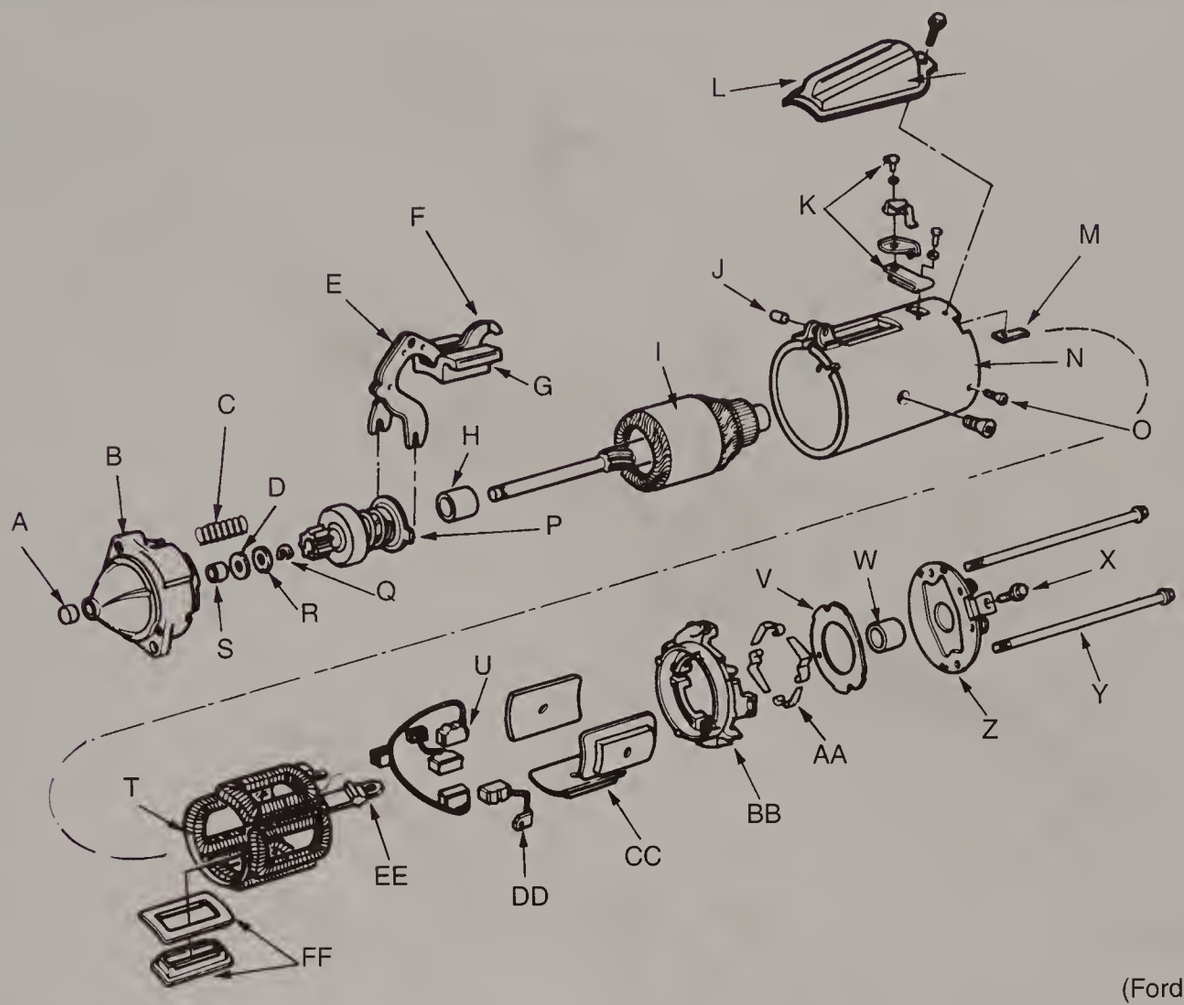
_____

_____

_____

Name _____

18. Identify the parts indicated on the exploded view of the positive engagement starter shown below.

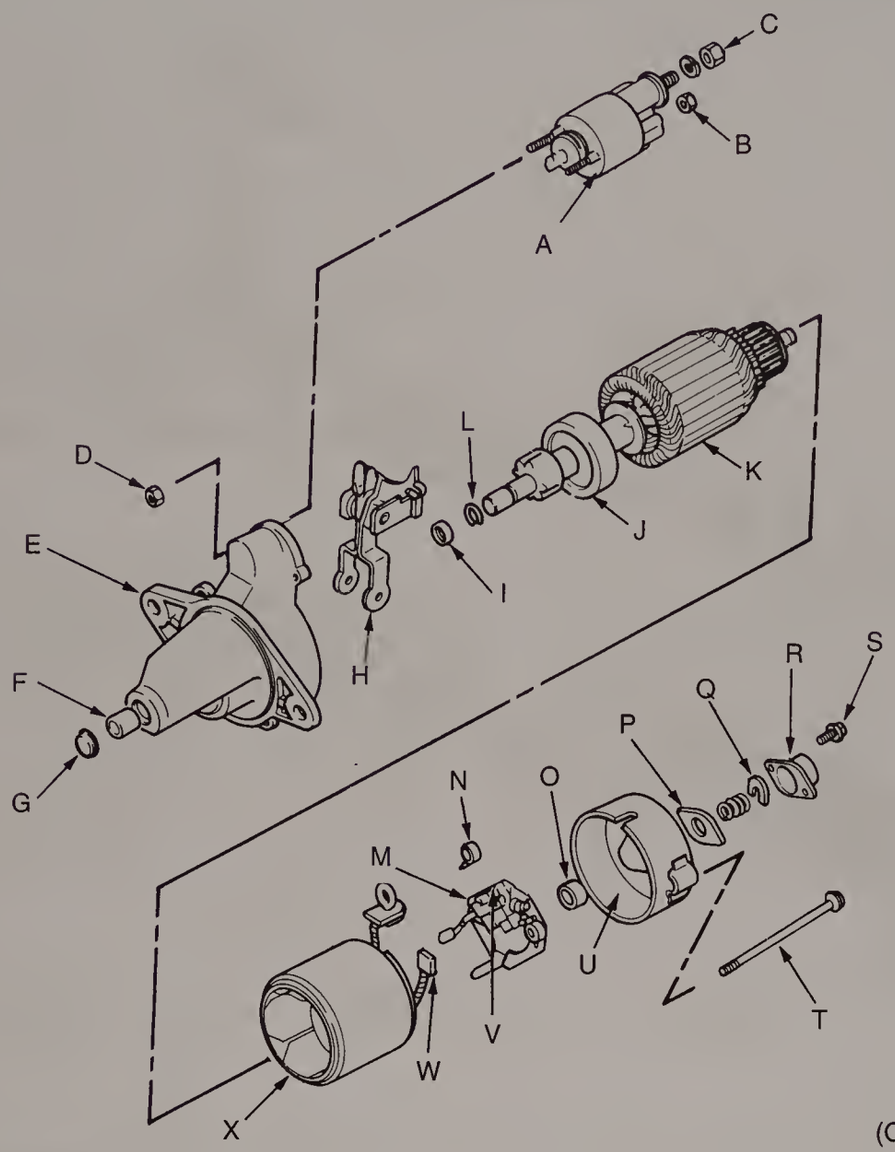


(Ford)

18. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____

(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____
(Z) _____
(AA) _____
(BB) _____
(CC) _____
(DD) _____
(EE) _____
(FF) _____

19. Identify the parts indicated on the exploded view of the solenoid-engaged starter below.

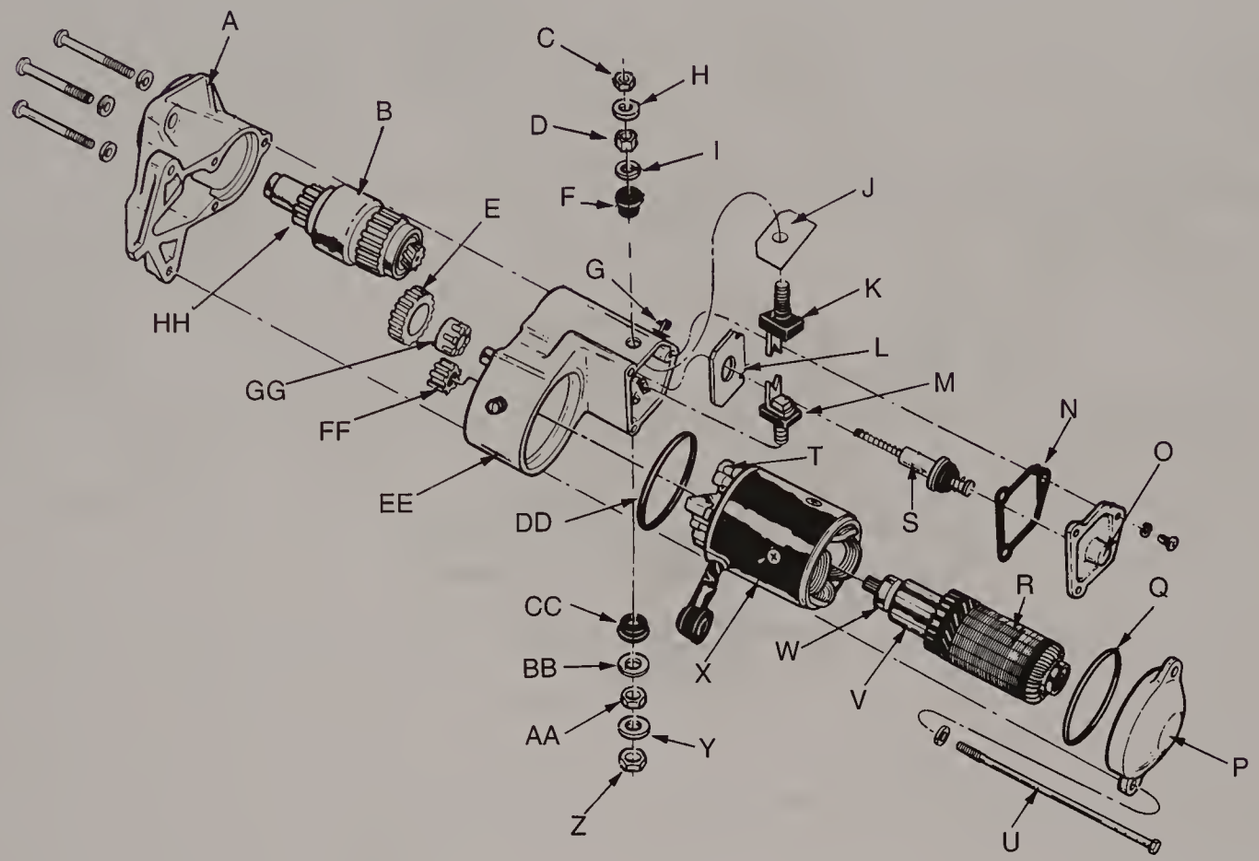


(Oldsmobile)

19. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____

Name _____

20. Identify the parts indicated on the exploded view of a gear reduction starting motor below.



(General Motors)

20. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____
(Z) _____
(AA) _____
(BB) _____
(CC) _____
(DD) _____
(EE) _____
(FF) _____
(GG) _____
(HH) _____

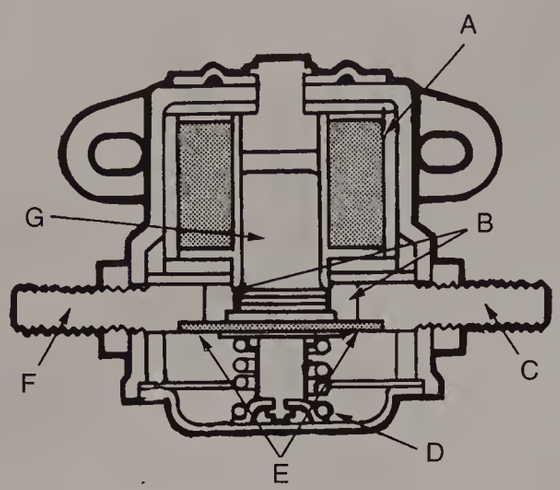
21. List three functions of a starter solenoid.

_____

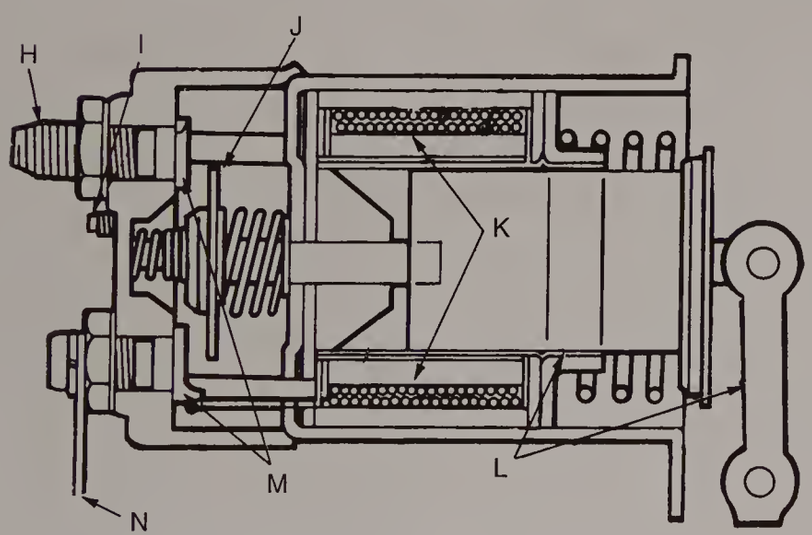
_____

_____

22. Name the two types of solenoids below and identify the parts indicated on them.



Type: _____



(Chrysler)

Type: _____

22. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(I) _____

(J) _____

(K) _____

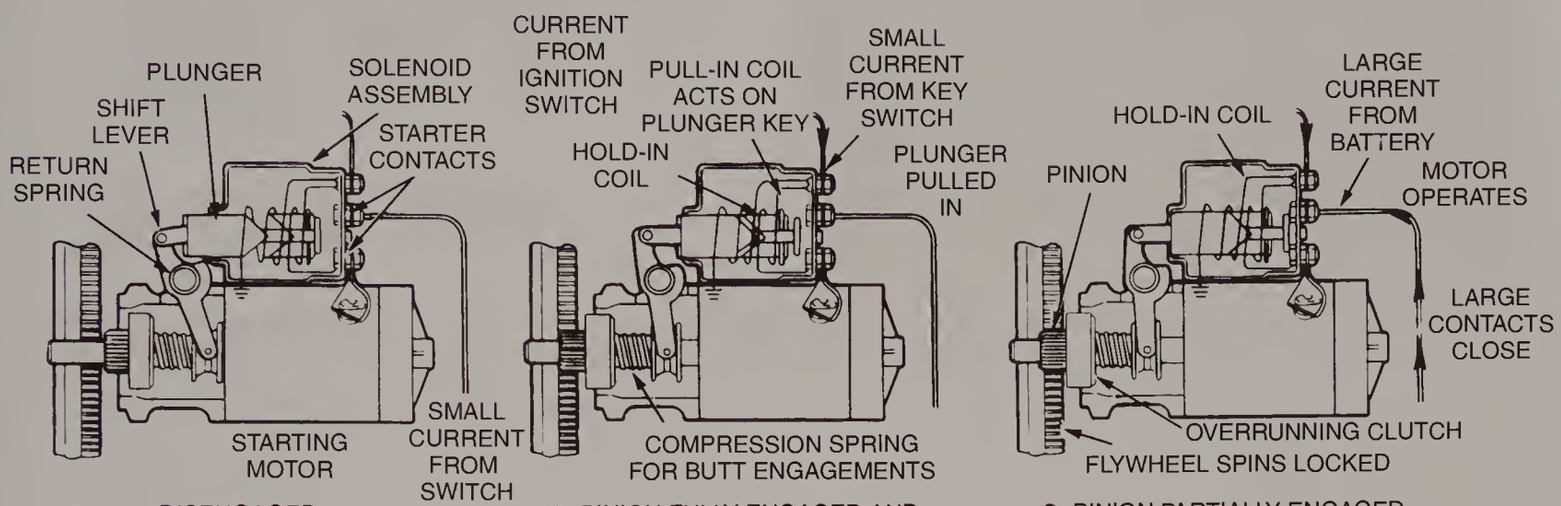
(L) _____

(M) _____

(N) _____

Name _____

23. Describe what is happening in the diagrams below.



A DISENGAGED

B PINION FULLY ENGAGED AND STARTING MOTOR CRANKING

C PINION PARTIALLY ENGAGED

(Chrysler)

(A) _____

_____

(B) _____

_____

(C) _____

_____

Starter Relay

24. A starter relay uses a _____ (large, small) current flow from the ignition switch to control a slightly larger current flow to the starter solenoid. 24. _____

25. A(n) _____ safety switch prevents the engine from cranking unless the shift lever is in neutral or park. 25. _____

26. A(n) _____ safety switch can be used with cars using manual transmissions or transaxles to prevent engine cranking. 26. _____

27. A neutral safety switch and the clutch safety switch are usually wired in _____ with the starter solenoid or relay. 27. _____

Name _____

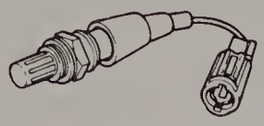
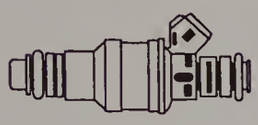
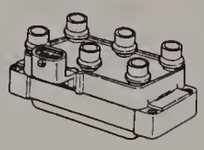
Date _____

Instructor _____

Score _____ Text pages 227–242

Chapter 14

Charging Systems

After studying this chapter and completing supplemental exercises, you will be able to:

- Sketch a basic charging circuit diagram.
- Explain the operation of a charging system.
- Identify the parts of an alternator.
- Explain the function of major alternator components.
- Summarize the construction of charging system parts.
- Describe voltage regulator variations.
- Explain AC rectification.
- Compare conventional and pulsed field regulation.
- Review DC generator operation.
- Explain the construction and operation of an alternator-mounted vacuum pump.

Instructions: As you study Chapter 14 of the text, complete the following workbook problems in the spaces provided.

Basic Charging Circuit

1. List and describe the seven fundamental components of a charging system.

Purpose of the Charging System

2. Name the four functions of the charging system.

_____

_____

_____

_____

_____

_____

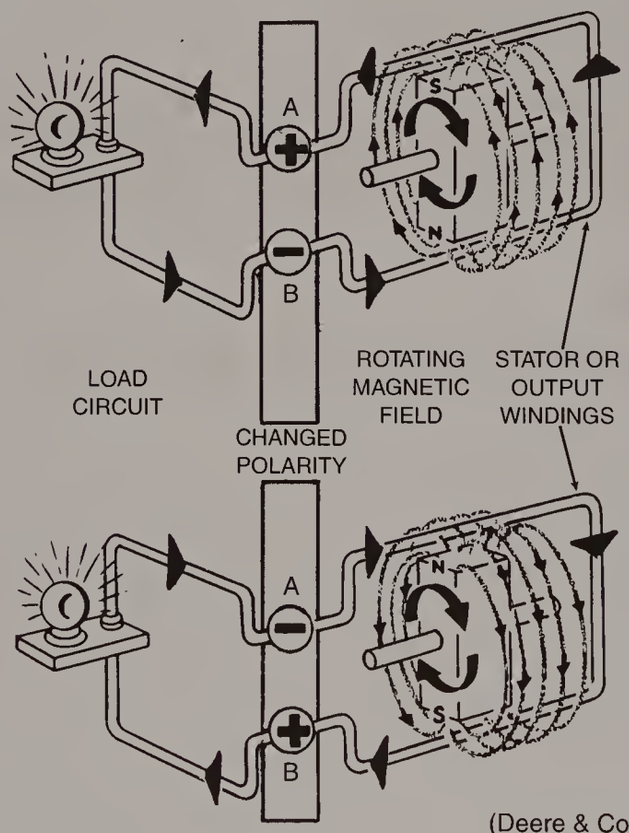
Alternator Operation

3. What is the alternator designed to do? _____

_____

_____

4. Describe what is happening in the diagram below.



(Deere & Co.)

_____

_____

_____

_____

5. The _____ is a spinning magnetic field that fits in the center of the alternator housing. 5. _____

Name _____

6. The _____ is a stationary set of windings in the alternator that serves as the output winding of the alternator. 6. _____

7. Alternator current must be _____ into direct current before entering the electrical system of a car. 7. _____

8. A(n) _____ is an electronic device that serves as a one-way check valve for electricity. 8. _____

9. A(n) _____ -_____ _____ means that both the positive and negative alternating current waves from the alternator stator are used to produce direct current. 9. _____

10. Identify the parts indicated on the diagram of the alternator below. 10. (A) _____

(B) _____

(C) _____

(D) _____

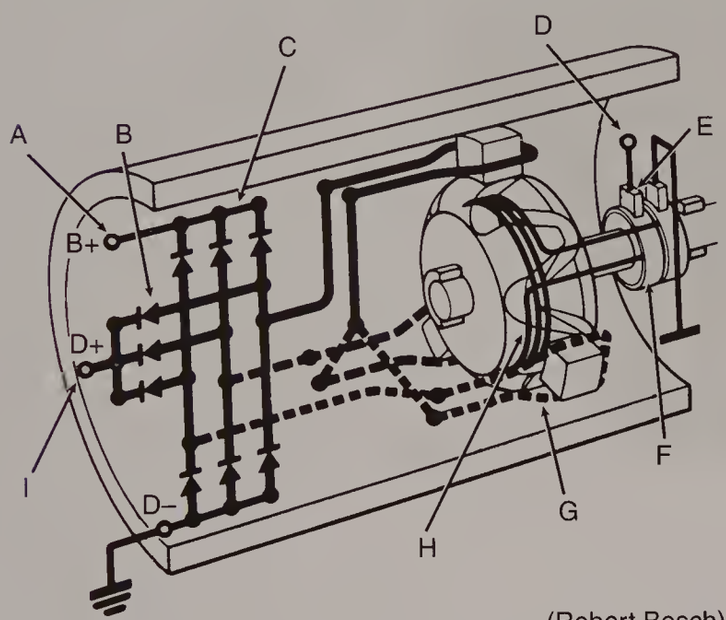
(E) _____

(F) _____

(G) _____

(H) _____

(I) _____



(Robert Bosch)

11. To protect the diodes from overheating damage, a(n) _____ _____ can be used. 11. _____

Alternator Construction

12. List the typical components of an alternator.

_____

_____

_____

_____

_____

_____

_____

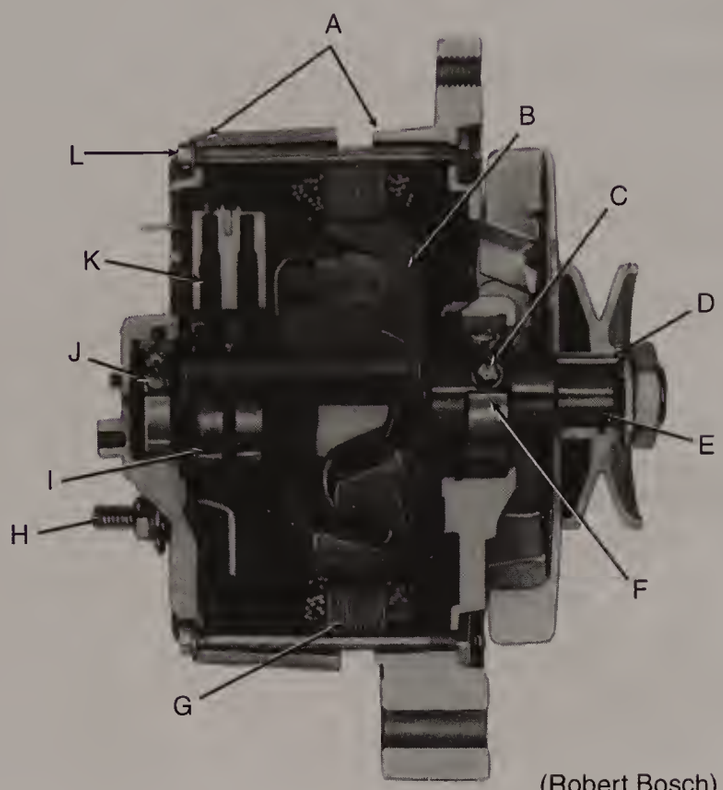
_____

_____

_____

_____

13. Identify the parts indicated on the photograph of the alternator below.

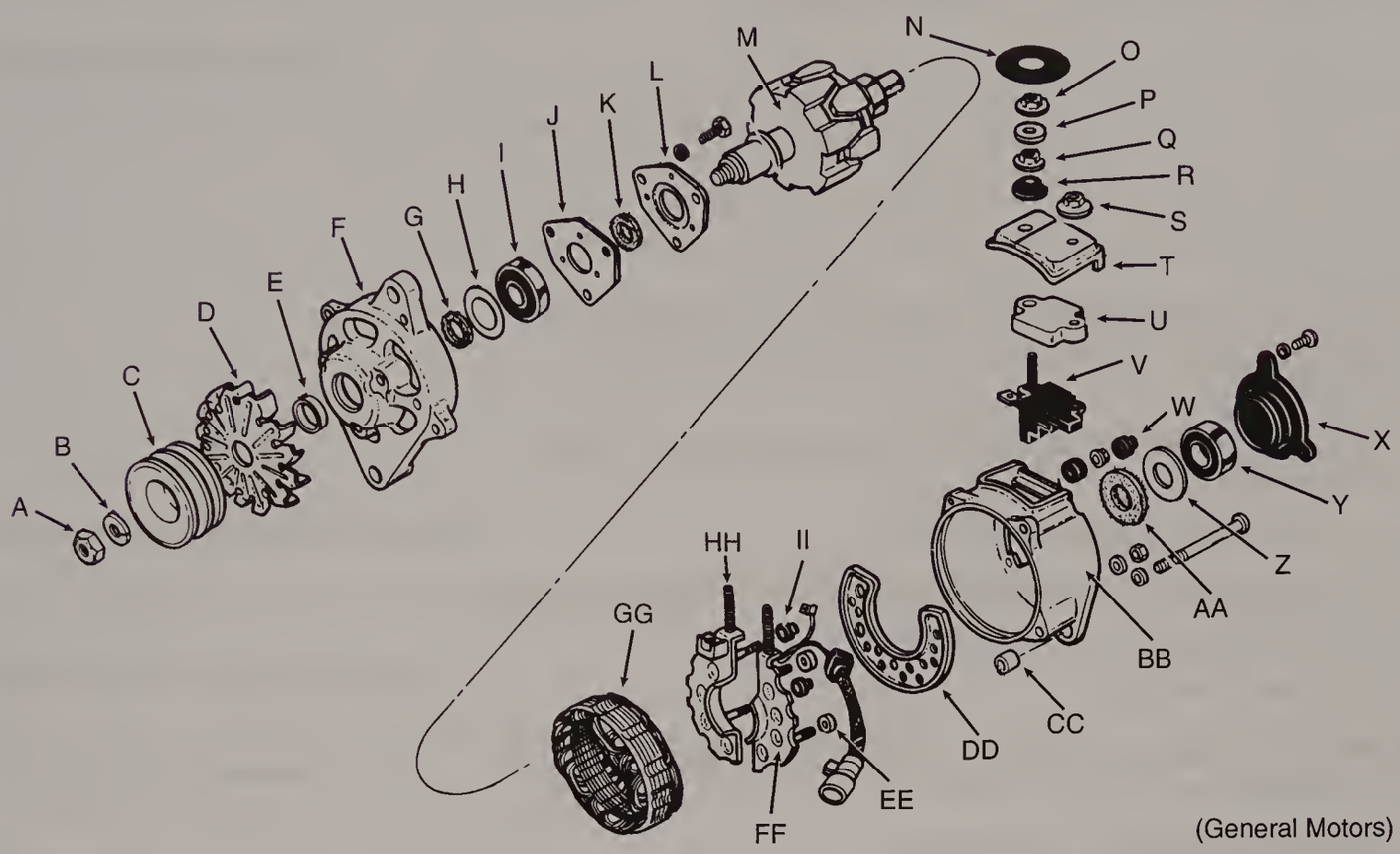


(Robert Bosch)

13. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

Name _____

14. Identify the parts indicated on the diagram below.



(General Motors)

14. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____

(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____
(Z) _____
(AA) _____
(BB) _____
(CC) _____
(DD) _____
(EE) _____
(FF) _____
(GG) _____
(HH) _____
(II) _____

Voltage Regulators

15. Name the four basic types of voltage regulators.

_____

_____

_____

_____

16. The _____ voltage regulator, mounted inside or on the rear of the alternator, is the most common type of electronic regulator on today's cars. 16. _____

17. Some newer electronic regulators are temperature compensating. This means: 17. _____

(A) output voltage is always increased.

(B) the regulator changes alternator output with outside temperatures.

(C) output voltage is always decreased.

(D) None of the above.

18. How the voltage regulator can cycle the rotor field current on and off to control charging system output is _____ _____ _____. 18. _____

19. An alternator capacitor or condenser: 19. _____

(A) absorbs alternating current inside the AC generator.

(B) protects the rectifying diodes from high voltage spikes and damage.

(C) can be used to prevent radio noise.

(D) All of the above.

20. The contact point voltage regulator is an older type of regulator that has been replaced by _____ or solid state regulators. 20. _____

Computer-Controlled Voltage Regulation

21. A(n) vehicle's on-board computer is used to monitor the alternator's _____ in a computer-controlled voltage regulation system. 21. _____

22. The duty cycle is the amount of time that current is fed to the alternator's _____ _____. 22. _____

Types of Charging Systems

23. Name two basic types of charging systems.

_____

_____

Name _____

24. The _____ type charging system has replaced the older DC generator. 24. _____

Charge Indicators

25. Name and describe the three basic types of charge indicators.

_____

_____

_____

_____

_____

_____

Alternator Vacuum Pump

26. An alternator vacuum pump is commonly used with _____ engines. 26. _____

Alternator High Voltage

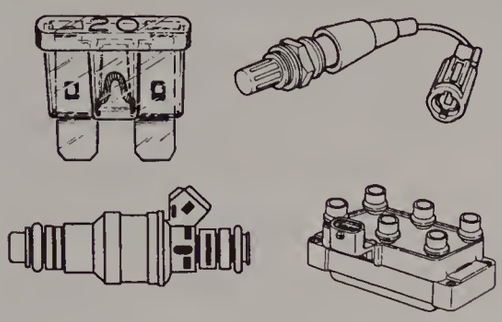
27. When the windshield heater element is activated, a control module switches the alternator to _____ _____ and sends the resulting high voltage output only to the windshield. 27. _____

Name _____

Date _____

Instructor _____

Score _____ Text pages 243–268



Chapter 15

Ignition Systems

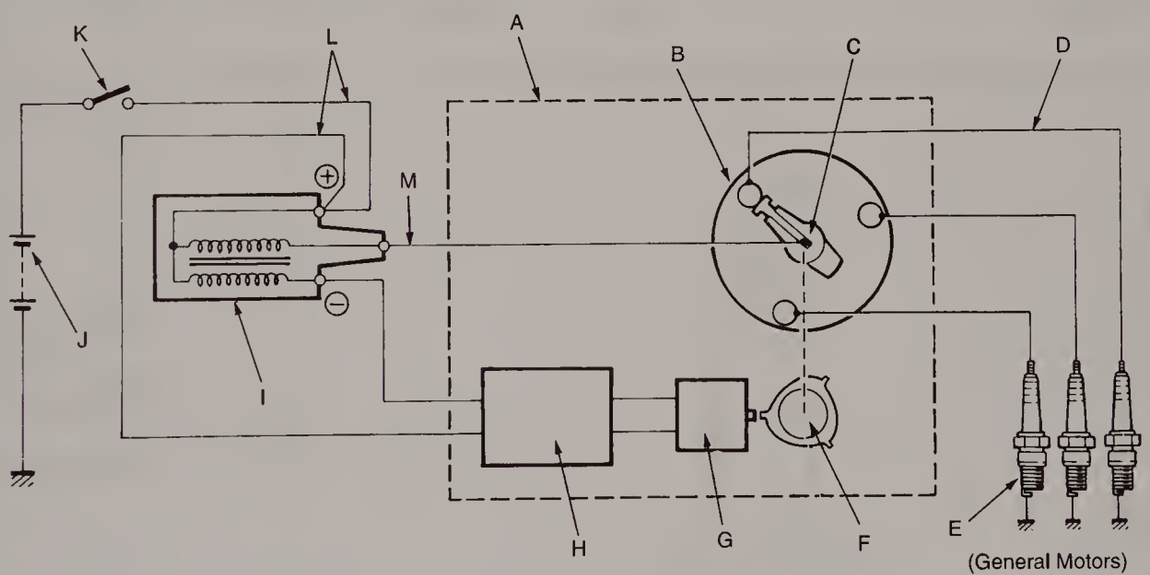
After studying this chapter and completing supplemental exercises, you will be able to:

- Describe the basic principles of an ignition system.
- Compare the various types of ignition systems.
- Explain the construction and operation of major ignition system components.
- Explain the various methods of spark advance.
- Describe distributor types.
- Explain distributorless and direct ignition system variations.

Instructions: As you study Chapter 15 of the text, complete the following workbook problems in the spaces provided.

Ignition Systems Fundamentals

1. Identify the basic parts of the ignition system shown below.



(General Motors)

1. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(I) _____

(J) _____

(K) _____

(L) _____

(M) _____

2. _____ are compression ignition engines and do not need electronic ignition systems. 2. _____

3. Name and describe the basic parts of an ignition system. _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

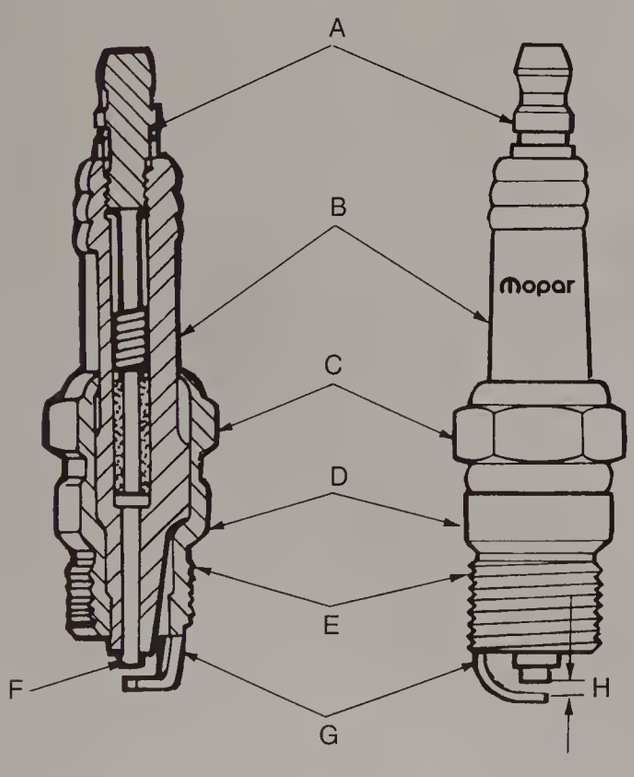
4. The ignition system's _____ (primary, secondary) circuit consists of all the components and wires operating on low voltage. 4. _____

5. The ignition system's _____ (primary, secondary) circuit includes all parts carrying high voltage ranging from 4000 to 30,000 volts. 5. _____

Spark Plugs

6. Identify the parts indicated on the diagram below.

6. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____



(Chrysler)

Name _____

7. Which of the following is grounded and causes the electricity to jump the gap and return to the battery through the frame ground? 7. _____

   (A) Spark plug center terminal.

   (B) Spark plug ceramic insulator.

   (C) Spark plug side electrode.

   (D) Spark plug shell.

8. The most common spark plug sizes are _____ mm and _____ mm. 8. _____

9. A(n) _____ spark plug helps prevent radiation of voltage that could upset operation of radios. 9. _____

10. The _____ _____ _____ makes contact with the cylinder head to seal in the pressure of combustion, allowing heat to transfer out of the plug and into the head to prevent plug overheating and detonation. 10. _____

    (A) resistor spark plug

    (B) spark plug seat

    (C) spark plug reach

    (D) None of the above.

11. The distance between the end of the plug threads and the seat or sealing surface on the plug is the _____ _____ _____. 11. _____

12. The _____ (long, short) spark plug insulator tip produces a colder running plug because more heat can transfer into the head. 12. _____

13. Spark plug _____ is the distance or air space between the center and side electrodes. 13. _____

    (A) gap

    (B) reach

    (C) seat

    (D) All of the above.

Spark Plug Wires

14. Spark plug wire boots protect the metal connectors from: 14. _____

    (A) corrosion.

    (B) oil.

    (C) moisture.

    (D) All of the above.

Engine Firing Order

15. How is engine firing order determined? _____

_____

_____

_____

_____

_____

_____

Ignition Coil

16. An ignition coil is a pulse-type transformer capable of producing a short burst of high _____ for starting combustion.

16. _____

17. Identify the parts of the ignition coil below.

17. (A) _____

(B) _____

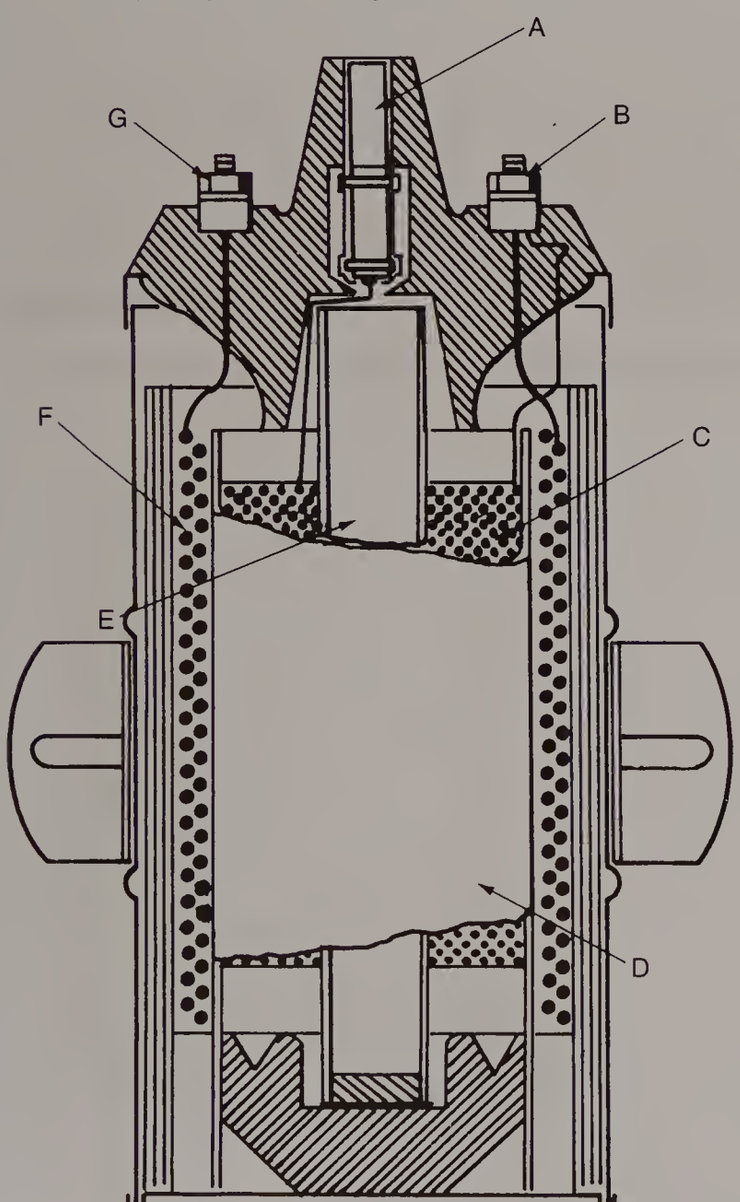
(C) _____

(D) _____

(E) _____

(F) _____

(G) _____



(Sun Electric)

Name _____

18. A strong _____ _____ is produced when battery current flows through the ignition coil primary windings. 18. _____

Ignition System Supply Voltage

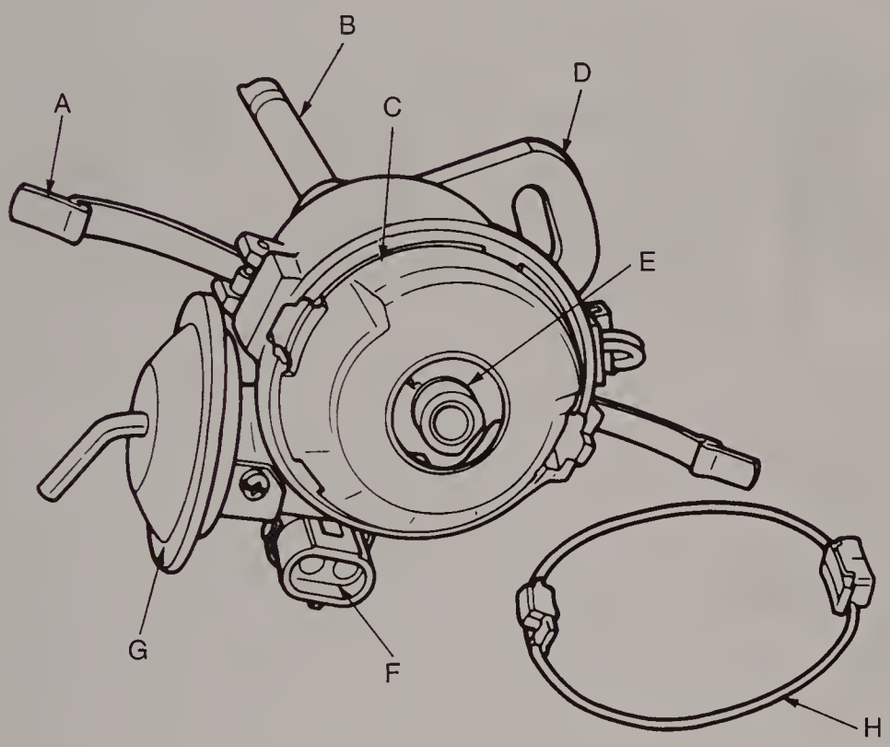
19. Many electronic ignition systems do not use _____ or resistance circuits. 19. _____

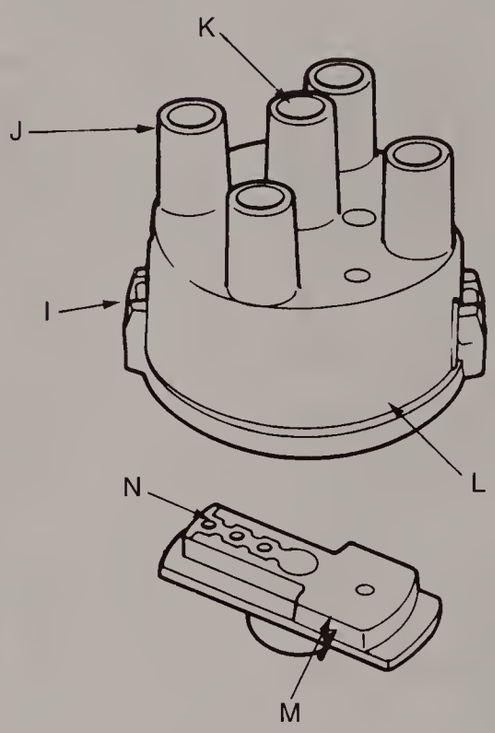
20. With a(n) _____ distributor or distributorless ignition, a coil wire is not needed. 20. _____

21. The distributor _____ transfers voltage from the distributor cap center terminal to the distributor cap outer terminals and plug wires. 21. _____

Ignition Distributors

22. Identify the parts indicated on the diagram below.





22. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____

23. Which type of distributor uses a semiconductor sensor to detect the rotation of trigger blades and sends a signal to the ignition control module? 23. _____

(A) Contact point distributor.

(B) Magnetic pickup distributor.

(C) Hall-effect distributor.

(D) Photodiode distributor.

24. Look at the diagram below. Describe how a magnetic pickup coil operates.

_____

_____

_____

_____

_____

_____

_____

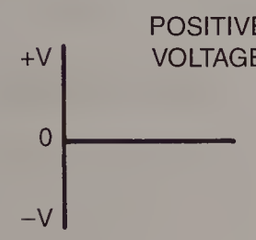
_____

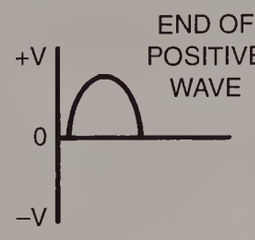
_____

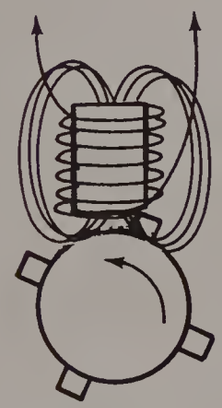
_____

_____

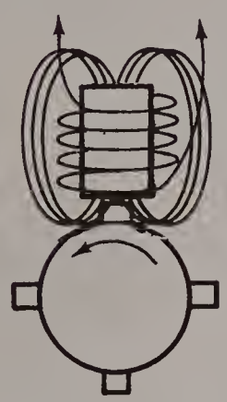
_____



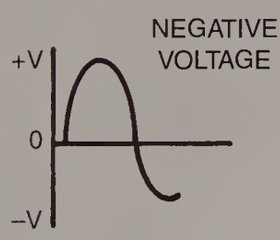


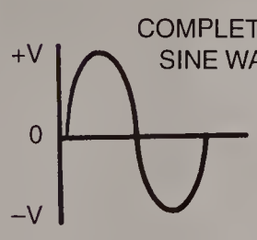


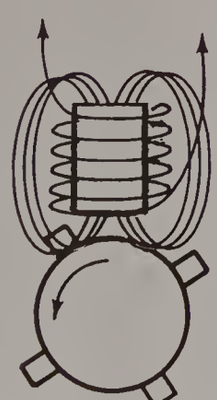
TOOTH BEGINS TO MOVE INTO COIL



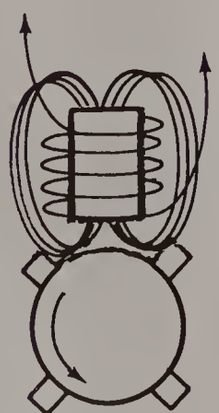
TOOTH ALIGNED WITH COIL







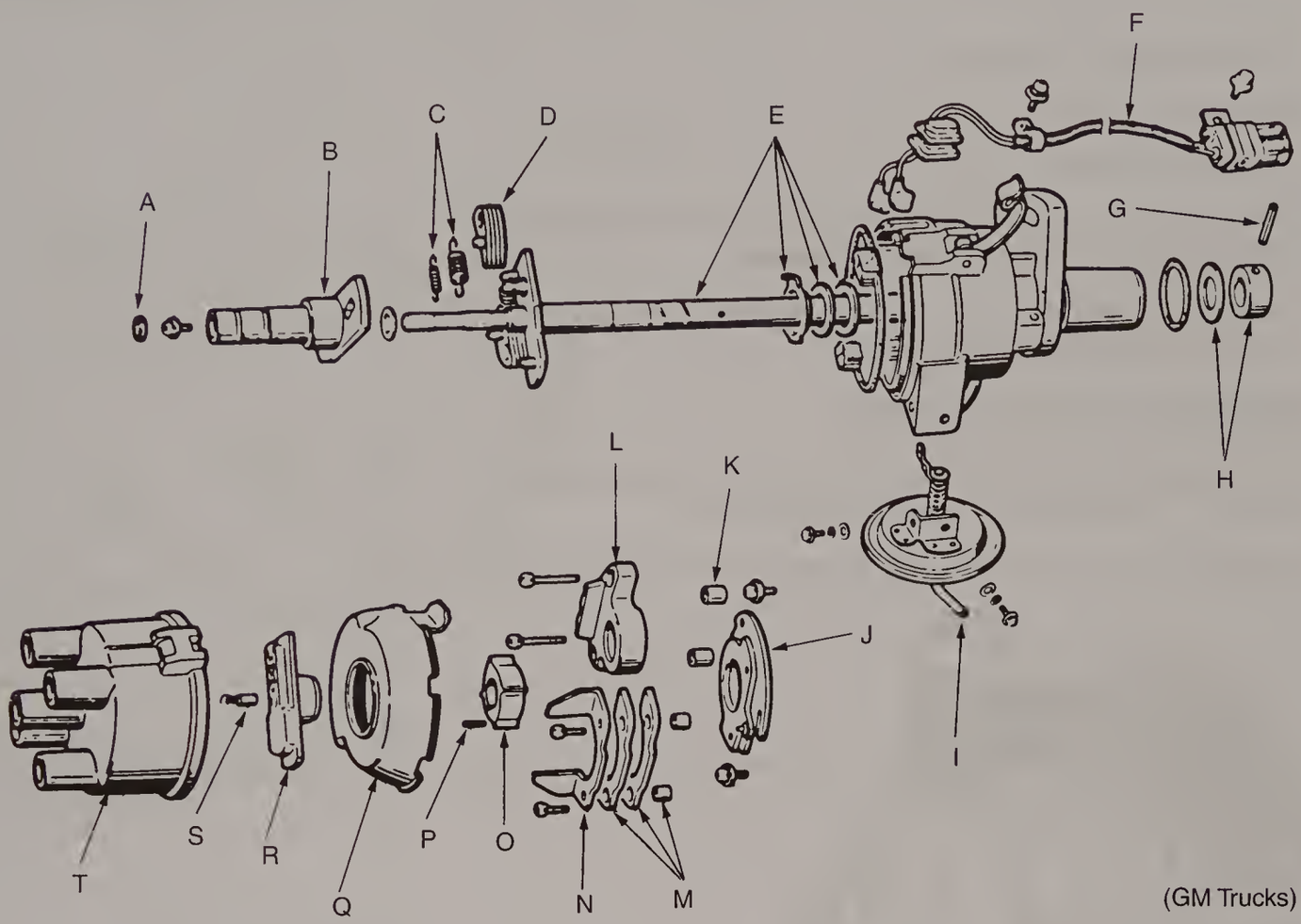
TOOTH MOVING AWAY FROM COIL



TEETH AWAY FROM COIL

Name _____

25. Identify the parts indicated on the diagram of the distributor below.



(GM Trucks)

25. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____

26. Which of the following is used to sense engine rpm? 26. _____

(A) Speed pickup coil.

(B) Crank angle pickup coil.

(C) Start pickup coil.

(D) Run pickup coil.

27. A(n) _____ _____ pickup is a semiconductor switch that reacts to the movement of a trigger wheel with blades. 27. _____

28. A distributor using a(n) _____ type speed sensor can react to or "see" the flashing light from an LED. 28. _____

Electronic Ignition System

29. An electronic ignition system uses an electronic control circuit and a(n) _____ pickup coil to operate the ignition coil. 29. _____

30. Identify the parts indicated on the illustration of the distributor below. 30. (A) _____

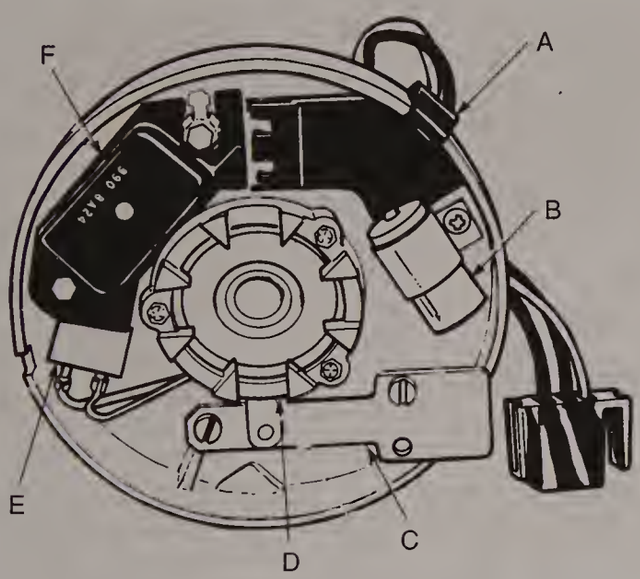
(B) _____

(C) _____

(D) _____

(E) _____

(F) _____



(General Motors)

Contact Point Ignition Systems

31. _____ _____ ignition systems are common on older cars. 31. _____

Ignition Timing

32. Which of the following is controlled by various engine sensors? 32. _____

(A) Distributor vacuum advance.

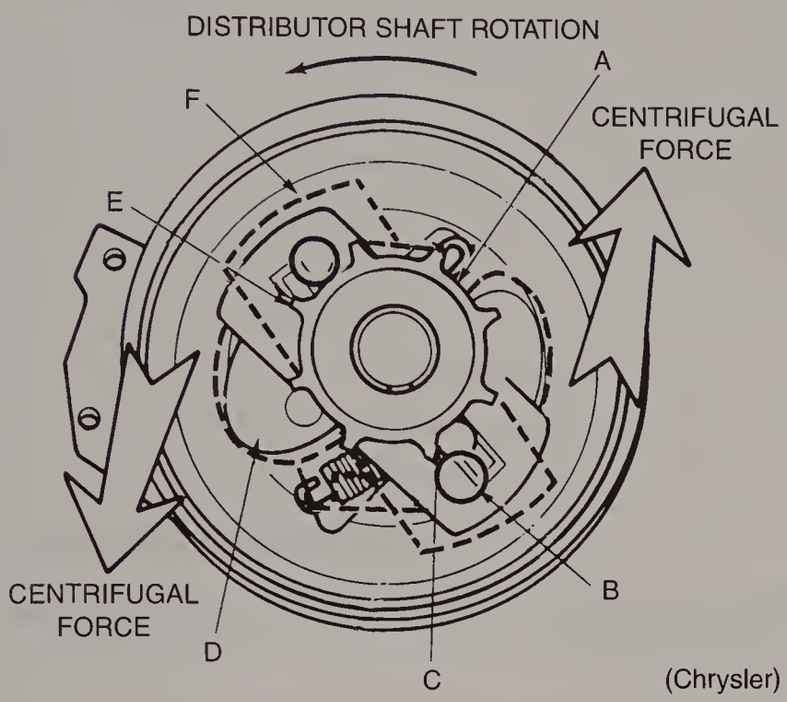
(B) Electronic (computer) advance.

(C) Distributor centrifugal advance.

(D) All of the above.

Name _____

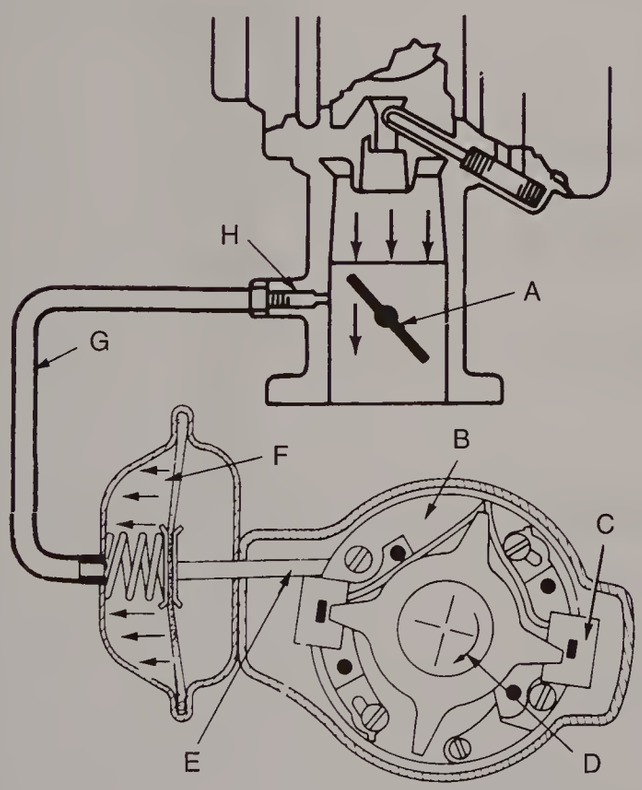
33. Identify what is indicated on the diagram of the distributor centrifugal advance below.



(Chrysler)

33. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

34. Identify what is indicated on the diagram of the distributor vacuum advance below.



(General Motors)

34. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

35. A dual-diaphragm vacuum advance mechanism is used on some _____ (newer, older) distributors. 35. _____

36. List nine sensors that can affect the ignition system.

_____

_____

_____

_____

_____

_____

_____

_____

_____

37. The _____ _____ _____ is used to retard ignition timing and, sometimes, turbocharger boost pressure during periods of engine knock, ping, or spark knock. 37. _____

38. A(n) _____ knock sensing system sends a low-voltage discharge across the spark plug gaps immediately following combustion. 38. _____

39. A(n) _____ _____ _____ can be used to limit maximum engine speed or rpm by operating a governor solenoid or by partially shutting off the engine system. 39. _____

Crankshaft Triggered Ignition

40. A crankshaft triggered ignition system places the _____ coil and trigger wheel (pulse ring) unit on the front of the engine. 40. _____

41. A(n) _____ _____ is usually mounted on the crankshaft damper to provide engine speed information to the pickup unit. 41. _____

42. A(n) _____ _____ _____ is mounted next to the crank pulse ring and sends electrical pulses to the system computer or ECM. 42. _____

Distributorless Ignition

43. A distributorless ignition uses which of the following to operate the spark plugs? 43. _____

(A) Multiple ignition coils and a coil control unit.

(B) Distributor.

(C) Engine sensors and a computer.

(D) Both (A) and (C).

44. The distributorless ignition system has multiple coils and a coil control _____ that replaces the distributor. 44. _____

Name _____

45. List five advantages a distributorless ignition system has over ignition systems with a distributor.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Direct Ignition System

46. No plug wires or conductor strips are needed in _____ ignition systems.

46. _____

47. Identify the parts indicated on the diagram of the ignition coil for a direct ignition system shown below.

47. (A) _____

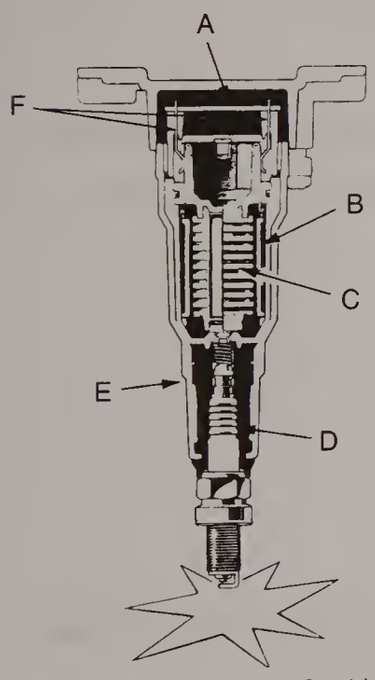
(B) _____

(C) _____

(D) _____

(E) _____

(F) _____



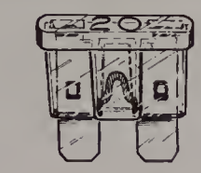
(Saab)

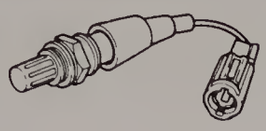
Name _____

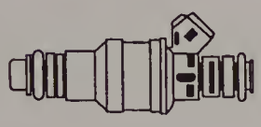
Date _____

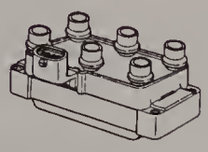
Instructor _____

Score _____ Text pages 269–290









Chapter 16

Fuel and Emission Control Systems Electronics

After studying this chapter and completing supplemental exercises, you will be able to:

- Sketch a block diagram for a computerized fuel system.
- Summarize the overall operation of a modern computerized fuel system.
- Explain the construction and operation of electrical-electronic components in a fuel system.
- Review how the oxygen sensor produces open and closed loop fuel system operation.
- Summarize the modes of fuel system operation.
- Describe how a computer alters idle speed and fuel mixture ratios.
- Explain the use of electronics in diesel fuel systems.
- Describe the control and operation of electric fuel pumps.
- Review the use of electronics in emission control systems.

Instructions: As you study Chapter 16 of the text, complete the following workbook problems in the spaces provided.

Fuel System Types

1. Name and describe three common types of fuel system classifications.

_____

_____

_____

_____

_____

_____

Electronic Gasoline Injection

2. The electronic gasoline injection is replacing the electronic or computer-controlled _____. 2. _____

3. _____-_____ fuel injection is more common and has replaced single-point fuel injection on all new models. 3. _____

4. Name and describe the three basic classifications of gasoline injection timing.

5. Which of the following types of injectors has the injectors opening one after the other? 5. _____

   (A) Group.

   (B) Sequential.

   (C) Simultaneous.

   (D) None of the above.

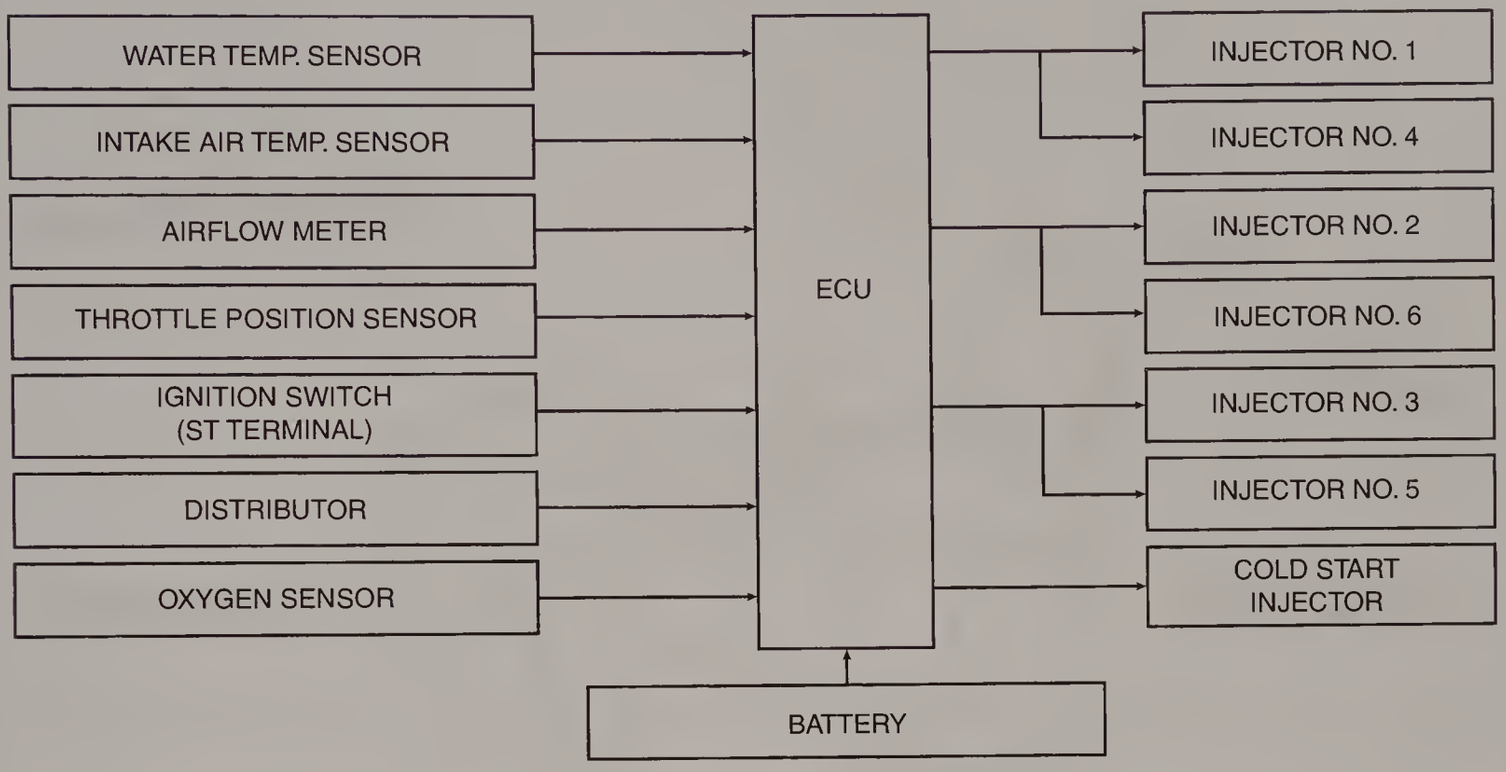
Fuel System Sub-Systems

6. Name and describe the three types of fuel system sub-systems.

Name _____

Fuel System Diagrams and Schematics

7. In the block diagram below, the _____ (actuators, sensors) are on the right. 7. _____



8. A fuel system diagram uses simple drawings and lines to show the _____ of components. 8. _____

9. A very detailed circuit drawing using symbols to represent components and lines to represent wires is a: 9. _____

(A) fuel system diagram.

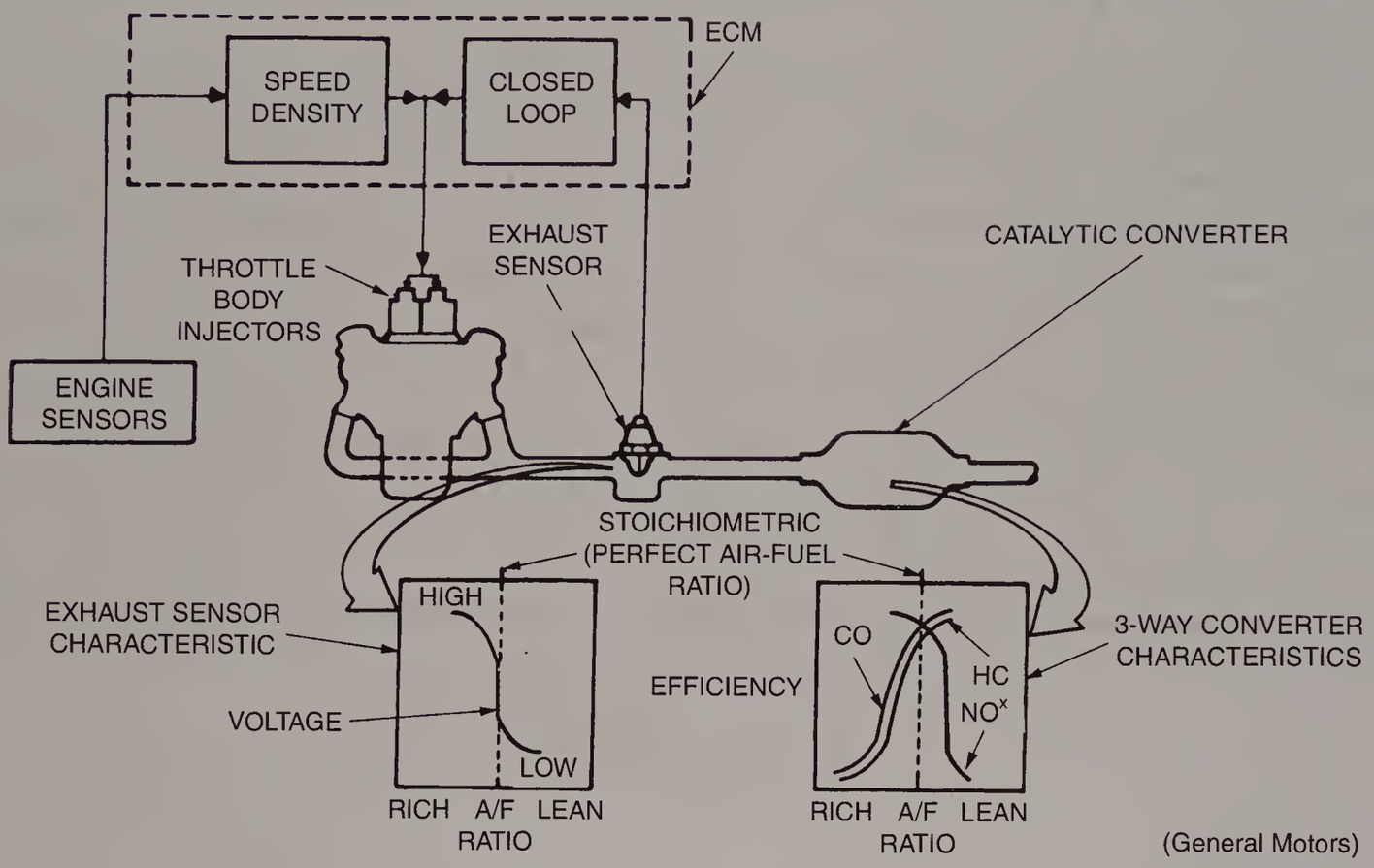
(B) block diagram.

(C) fuel system schematic.

(D) None of the above.

Open Loop and Closed Loop

10. Describe what is happening in the diagram below.



(General Motors)

Fuel Back-Up Mode

11. What is the purpose of the fuel back-up mode?

Name _____

Gasoline Injectors

12. The tip of armature that opens and closes to control the spray of fuel from the injector describes which part of a gasoline injector? 12. _____

(A) The terminal.

(B) The fuel inlet.

(C) The needle valve.

(D) The armature.

Injector Pulse Width

13. What is the injector pulse width?

_____

_____

_____

_____

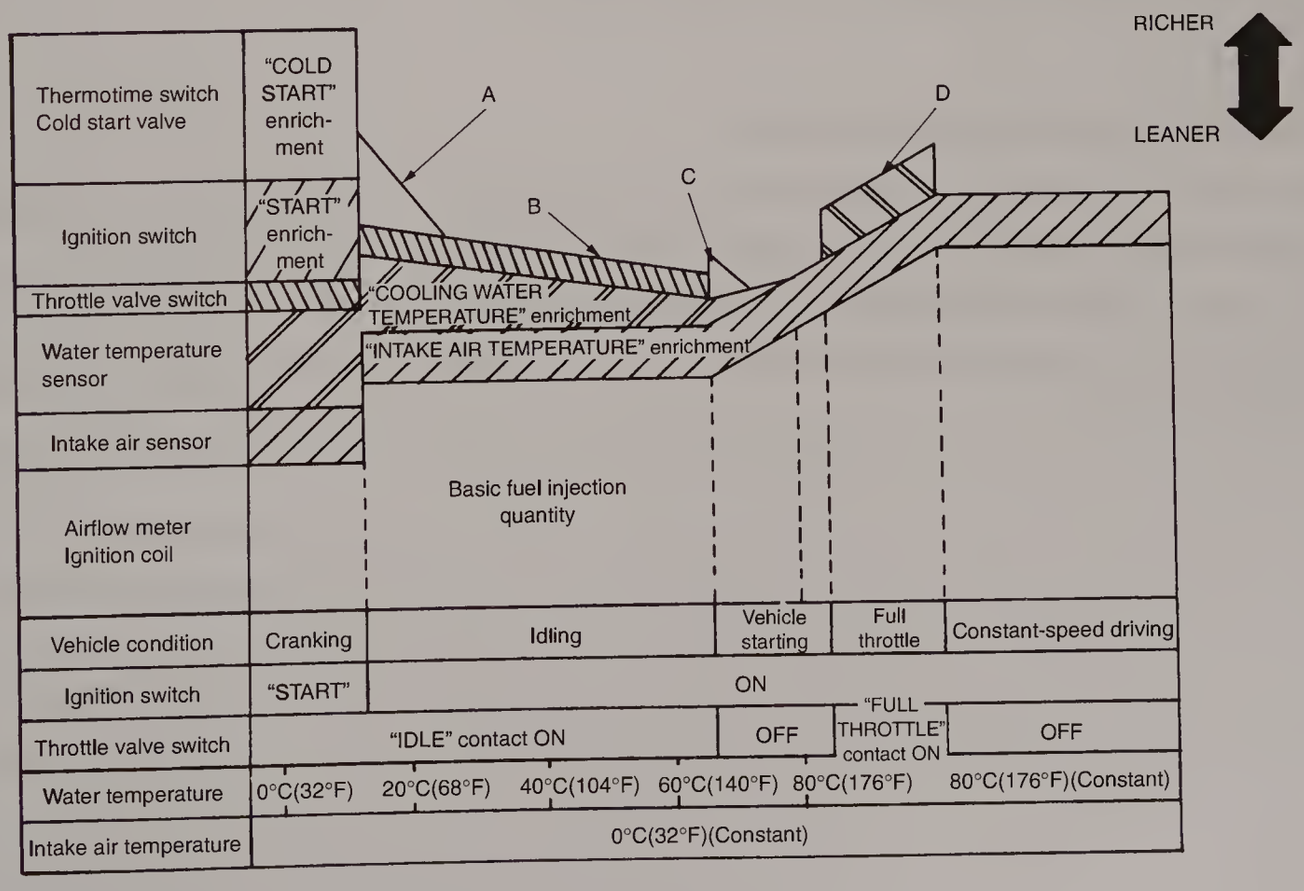
14. The top line of the graph below represents the engine _____ - _____ _____. 14. _____

15. Using the graph below, list the sensor conditions that increase graph height and fuel richness. 15. (A) _____

(B) _____

(C) _____

(D) _____



Air-Assisted Fuel Injection

16. An air-assisted fuel injection system allows fresh air to be drawn into the injectors, improving fuel _____. 16. _____

Idle Air Control Valve

17. When open, the idle air control valve allows more air to enter the intake manifold which tends to _____ (decrease, increase) engine idle rpm. 17. _____

Idle Speed Solenoid

18. An idle speed solenoid is frequently used on _____. 18. _____

Electric Choke

19. An electric choke is used on a(n) _____ to control the choke opening right after cold engine starting. 19. _____

Solenoid Bowl Vent

20. Upon engine restarting, the solenoid bowl vent usually _____ (closes, opens) and the vapors are drawn out of the canister and back into the engine for burning. 20. _____

Fuel Shut-Off Solenoid

21. A fuel shut-off solenoid improves fuel economy and decreases exhaust _____. 21. _____

Computer-Controlled Carburetors

22. In a computer-controlled carburetor, the air-fuel ratio is maintained by: 22. _____

(A) remaining on constantly.

(B) cycling the mixture solenoid on and off several times per second.

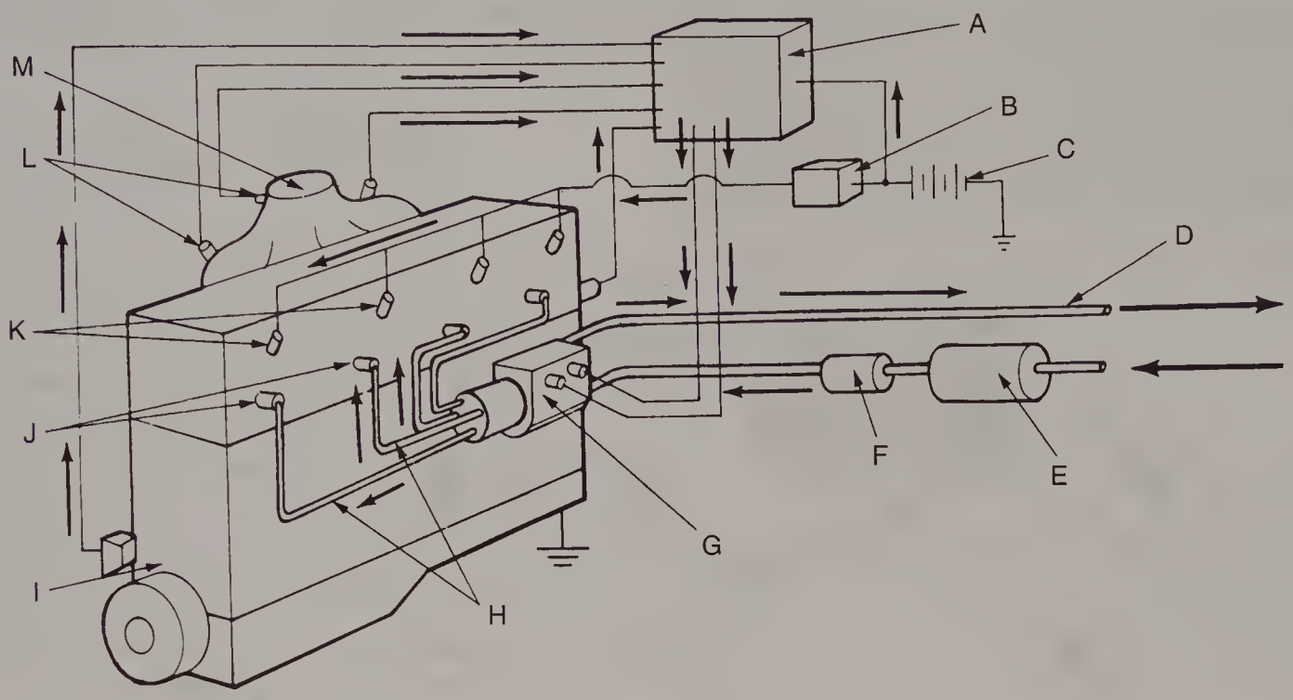
(C) remaining off for several minutes at a time.

(D) None of the above.

Name _____

Computer-Controlled Diesel Injection

23. Identify the parts indicated on the electronic diesel injection system shown below.



23. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____

Electric Fuel Pumps

24. An electric fuel pump provides _____ (delayed, instant) fuel pressure upon engine cranking. 24. _____

Emission Control Electronics

25. Which of the following are electronically-controlled emission control systems? 25. _____

(A) Computer-controlled catalytic converter.

(B) Electronically-controlled EGR.

(C) Electronic fuel evaporation control.

(D) All of the above.

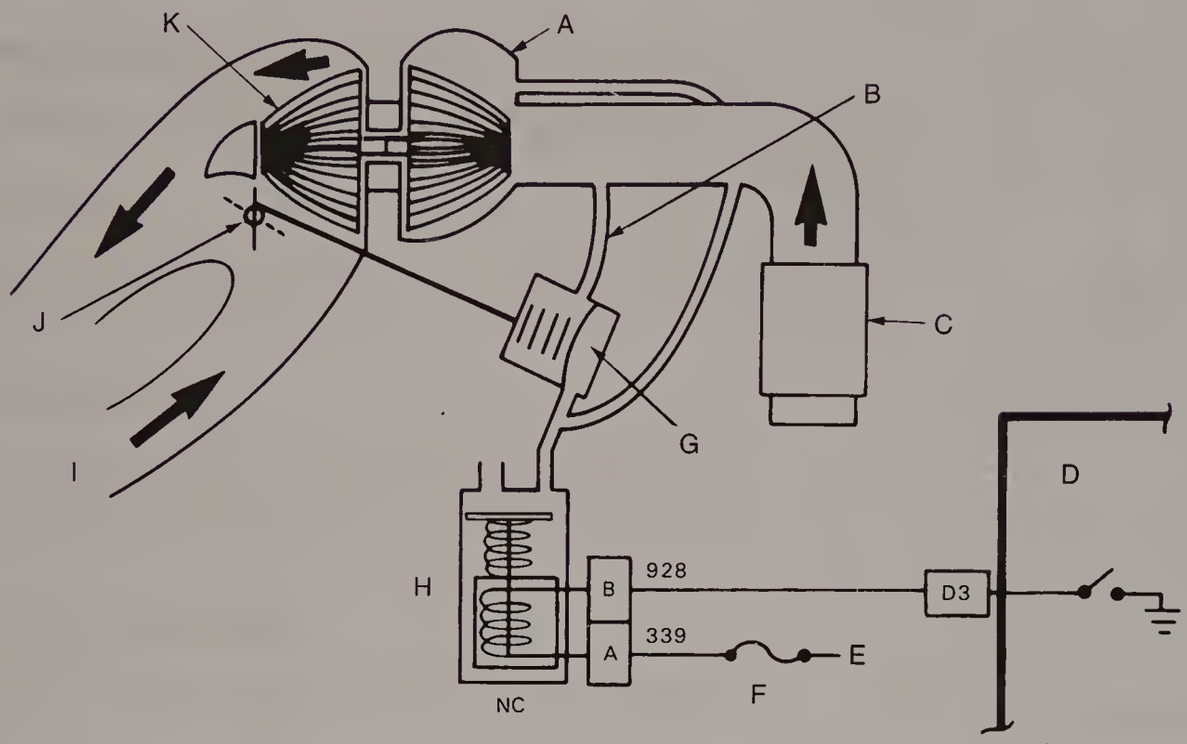
26. EGR stands for _____. 26. _____

27. _____ gases in an EGR system do not burn and help reduce combustion flame temperatures, resulting in a prevention of exhaust pollution. 27. _____

28. A key ingredient of a vapor cannister is _____ , which stores fuel vapors from the fuel system. 28. _____

Electronic Turbocharger Control

29. Identify the parts indicated on the diagram below.



(General Motors)

29. (A) _____ (G) _____

(B) _____ (H) _____

(C) _____ (I) _____

(D) _____ (J) _____

(E) _____ (K) _____

(F) _____

30. A vacuum diaphragm device that can open or close an exhaust passage to control turbo speed and boost pressure is the _____. 30. _____

Name _____

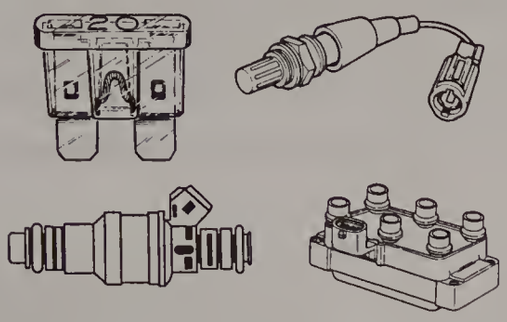
Date _____

Instructor _____

Score _____ Text pages 291–314

Chapter 17

Lighting Systems, Instrumentation



After studying this chapter and completing supplemental exercises, you will be able to:

- Sketch the wiring diagrams for the major lighting circuits.
- Explain the operation of a typical headlamp switch.
- Compare headlight bulb designs.
- Summarize lamp delay and auto-dimming systems.
- Explain brake, back-up, and turnlight circuit operation.
- Describe the various types of switches used in light and instrumentation systems.
- Sketch the circuits for basic gauge systems.
- Describe low fuel and fuel consumption indicator systems.
- Summarize instrument cluster construction.
- Compare conventional and digital instrumentation systems.
- Explain instrumentation computer operation.
- Summarize the operation of a CRT display.
- Describe the operation of a voice alert system.

Instructions: As you study Chapter 17 of the text, complete the following workbook problems in the spaces provided.

Lighting Systems

1. List six components of a lighting system.

_____

_____

_____

_____

_____

_____

2. Headlight beams are changed from low to high and vice versa by a(n) _____ switch. 2. _____

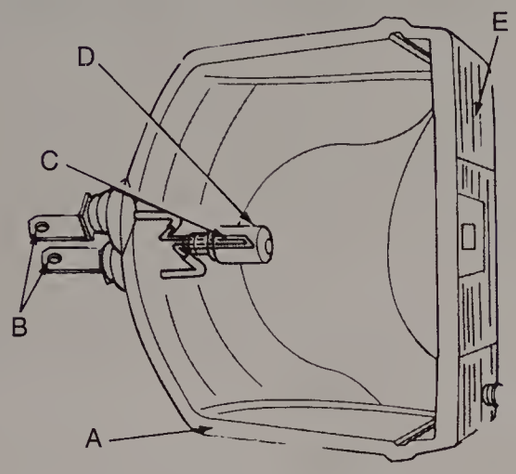
3. Name three types of headlamp beams.

_____

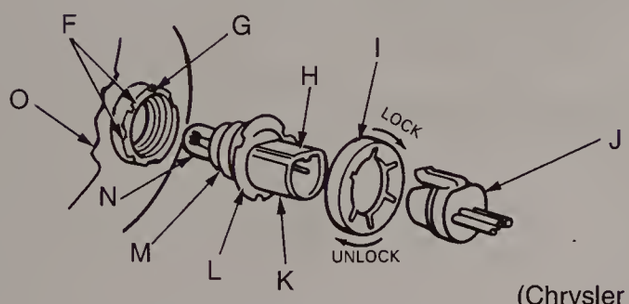
_____

_____

4. Identify the parts indicated on the diagram below.



SEALED HOUSING



(Chrysler and Ford)

HALOGEN BULB INSERT

4. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____

5. _____ headlamps use a vacuum or electric motor setup to swing the headlamps or headlamp doors up or down in the car body. 5. _____

6. An autolamp system uses which of the following to automatically control headlamp operation? 6. _____

(A) Light sensor.

(B) Control circuit and switch.

(C) Relay.

(D) All of the above.

Turn, Emergency, Stoplights

7. Name the components of the emergency flasher system.

_____

_____

_____

_____

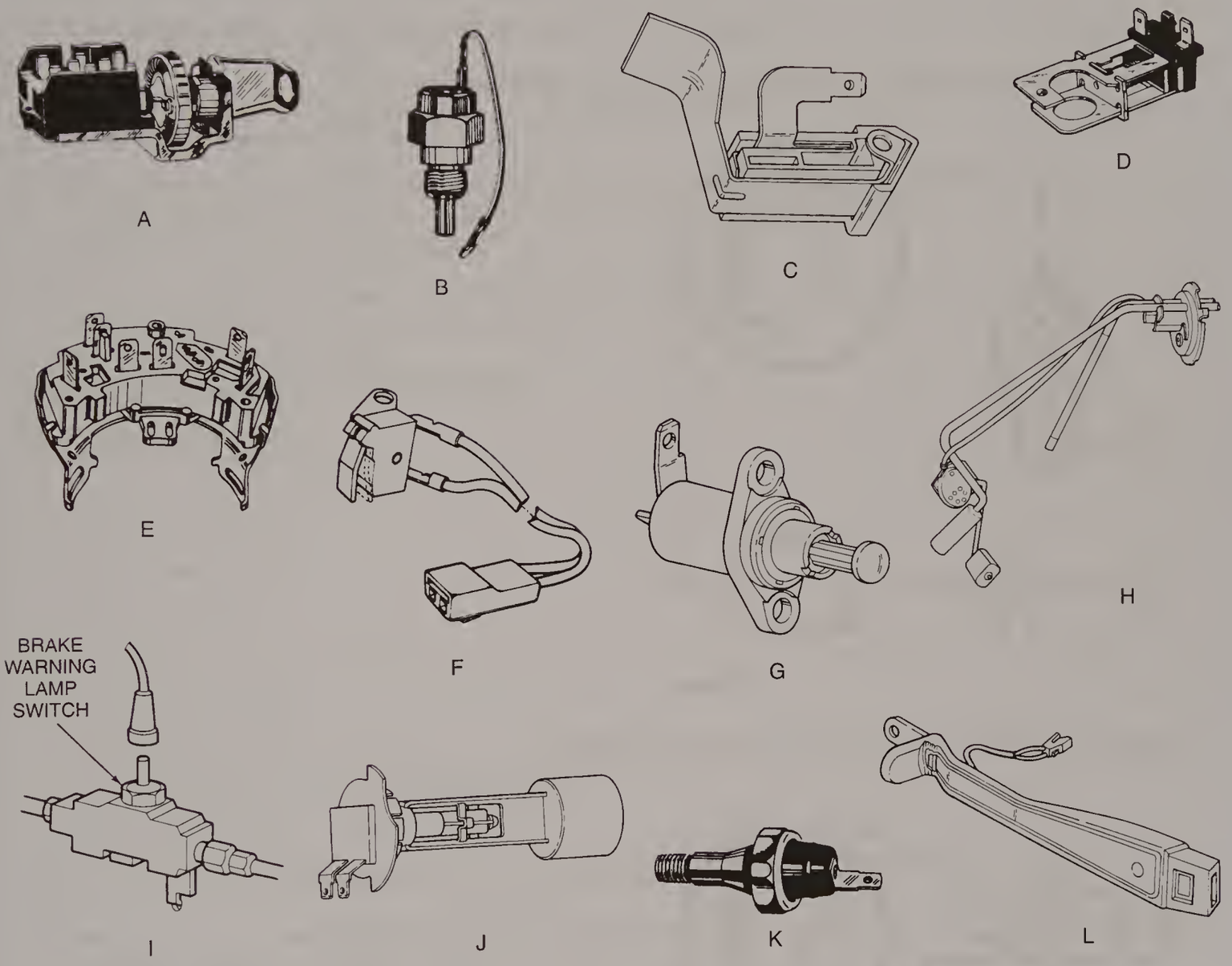
8. The brake light switch is normally mounted on or near the _____ _____. 8. _____

Name _____

9. The _____ light system uses a dash switch and door switches to operate small lights inside the passenger compartment. 9. _____

Light and Instrumentation Switches

10. Identify the various switches used in light and instrumentation systems.



(GP Parts and Chrysler)

10. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

Instrumentation Gauges

11. Gauges give warning _____ (after, before) engine damage occurs. 11. _____

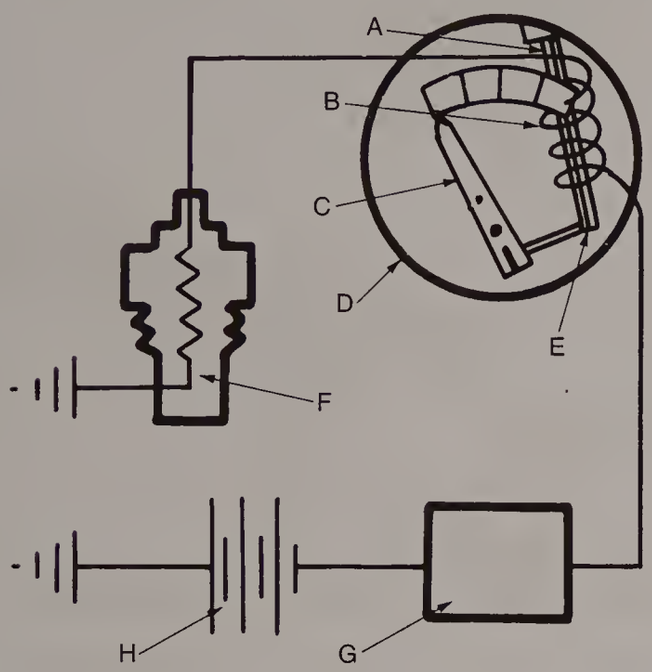
12. Name the two basic types of dash gauges used on modern passenger cars.

_____

_____

13. Identify the parts indicated on the basic temperature gauge circuit below.

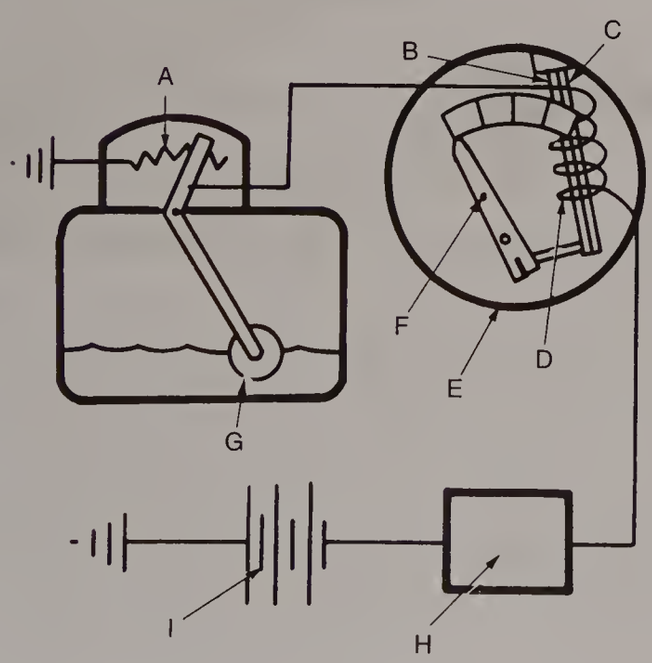
13. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____



(Chrysler)

14. Identify the parts indicated on the fuel gauge circuit below.

14. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____



(Chrysler)

Name _____

15. A(n) _____ _____ _____ uses the vehicle speed sensor, fuel flow sensor or tank sending unit, engine control computer, and possibly other inputs to show average fuel consumption and miles-to-empty displays. 15. _____

16. A low fuel warning light circuit can use either a control circuit or extra _____ mounted on the fuel tank sending unit. 16. _____

17. When the charging system is in good condition, the _____ should register around 13 to 15 volts. 17. _____

18. The oil pressure gauge circuit uses a(n) _____ resistance sending unit to operate a needle type gauge. 18. _____

19. To prevent the indicator light from flashing on and off as the oil splashes around inside the oil pan, a(n) _____ circuit is commonly used in the low oil level indicator system. 19. _____

20. The _____ uses the pulsing voltage or current going to the ignition coil to operate the indicator showing engine rpm. 20. _____

Instrument Cluster Construction

21. The instrument houses: 21. _____

    (A) most of the dash gauges.

    (B) the speedometer.

    (C) the indicator lights.

    (D) All of the above.

22. A digital instrument cluster uses: 22. _____

    (A) analog type gauges.

    (B) needle type gauges.

    (C) computer-driven number or graphic displays.

    (D) None of the above.

23. An electronic speedometer does not use a speedometer _____. 23. _____

24. A(n) _____ _____ system uses an electronic circuit to drive a speaker for verbally explaining conditions to the driver. 24. _____

Name _____

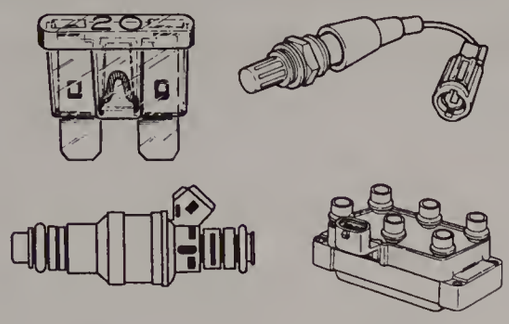
Date _____

Instructor _____

Score _____ Text pages 315–324

Chapter 18

Wiper and Horn Systems



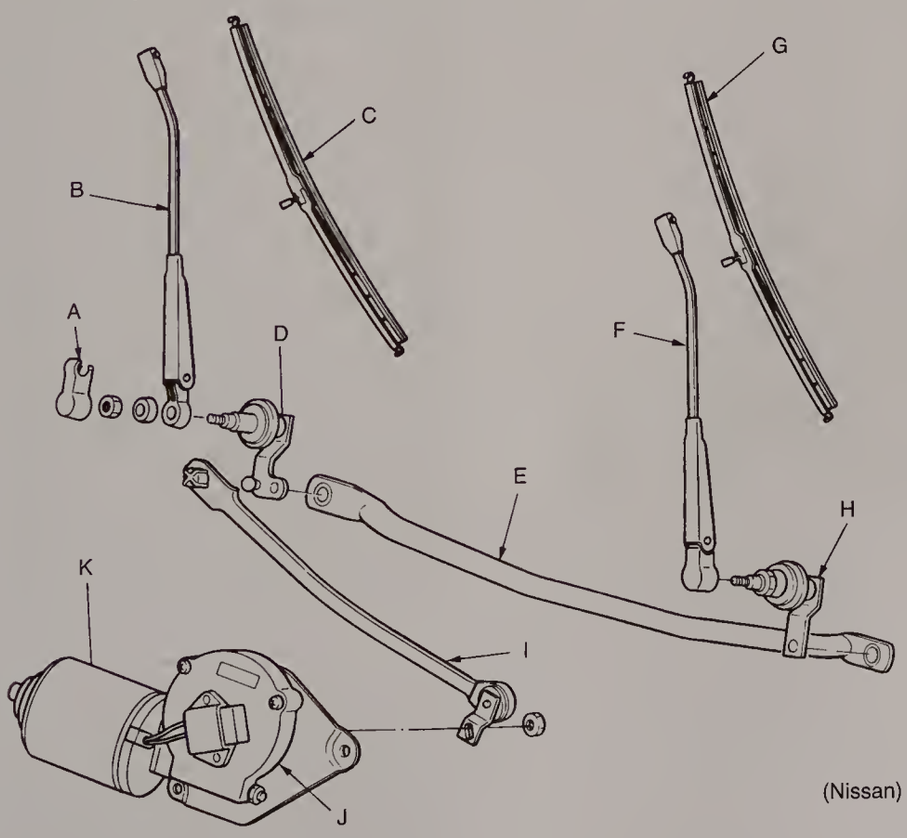
After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the major parts of a windshield wiper system.
- Describe how a windshield wiper system operates.
- Summarize the operation and parts of a typical windshield washer system.
- Compare variations in wiper-washer systems.
- Sketch a basic wiper-washer circuit.
- Explain the operation of a horn circuit.
- Describe the construction of a horn.
- Sketch a basic horn circuit.
- Summarize a typical theft deterrent system.

Instructions: As you study Chapter 18 of the text, complete the following workbook problems in the spaces provided.

Windshield Wiper System

1. Identify the basic parts of the windshield wiper system below.



(Nissan)

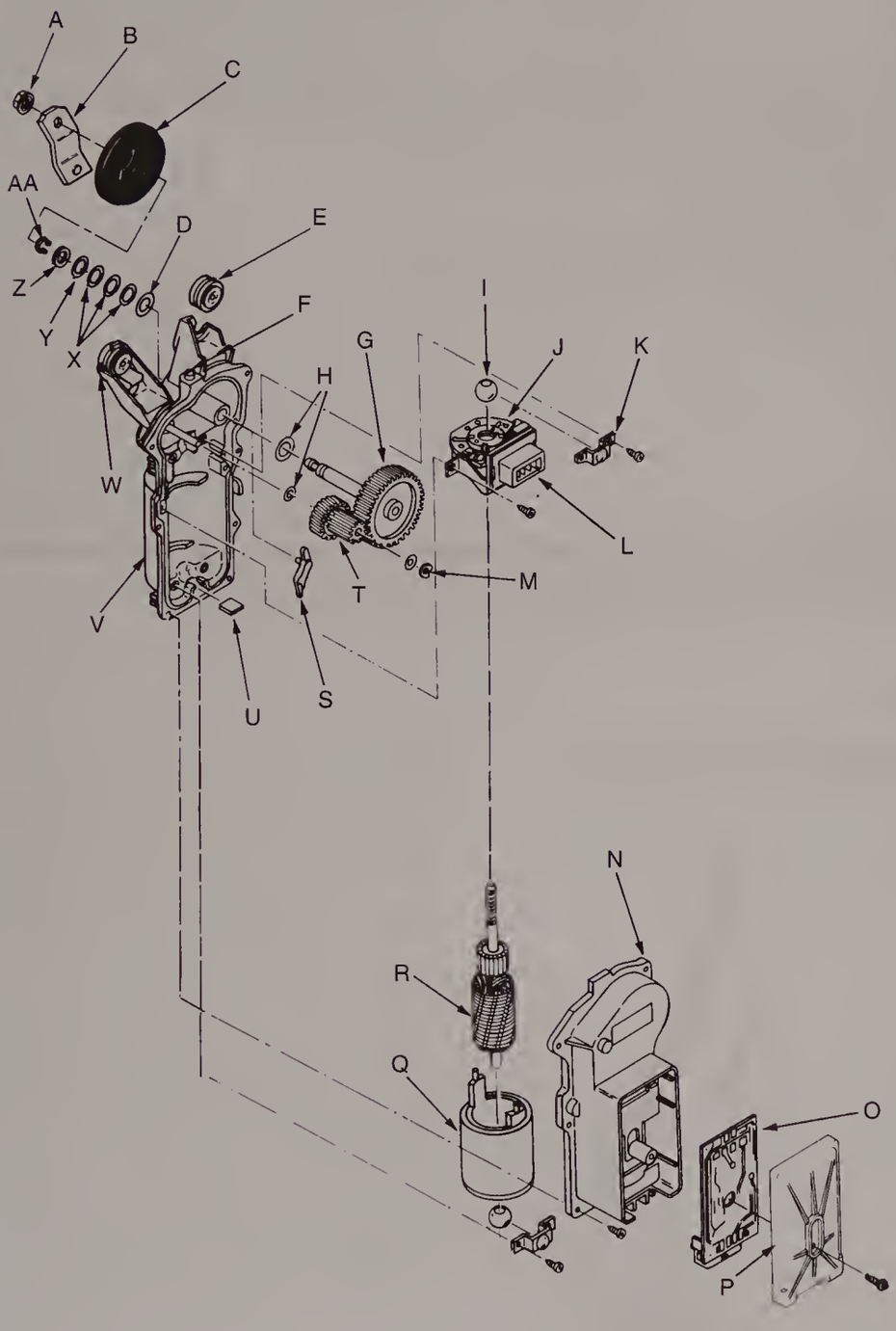
1. (A) _____
   (B) _____
   (C) _____
   (D) _____
   (E) _____
   (F) _____
   (G) _____
   (H) _____
   (I) _____
   (J) _____
   (K) _____

2. What part does the worm gear play in wiper operation?

_____

_____

3. Identify the parts indicated on the wiper motor below.



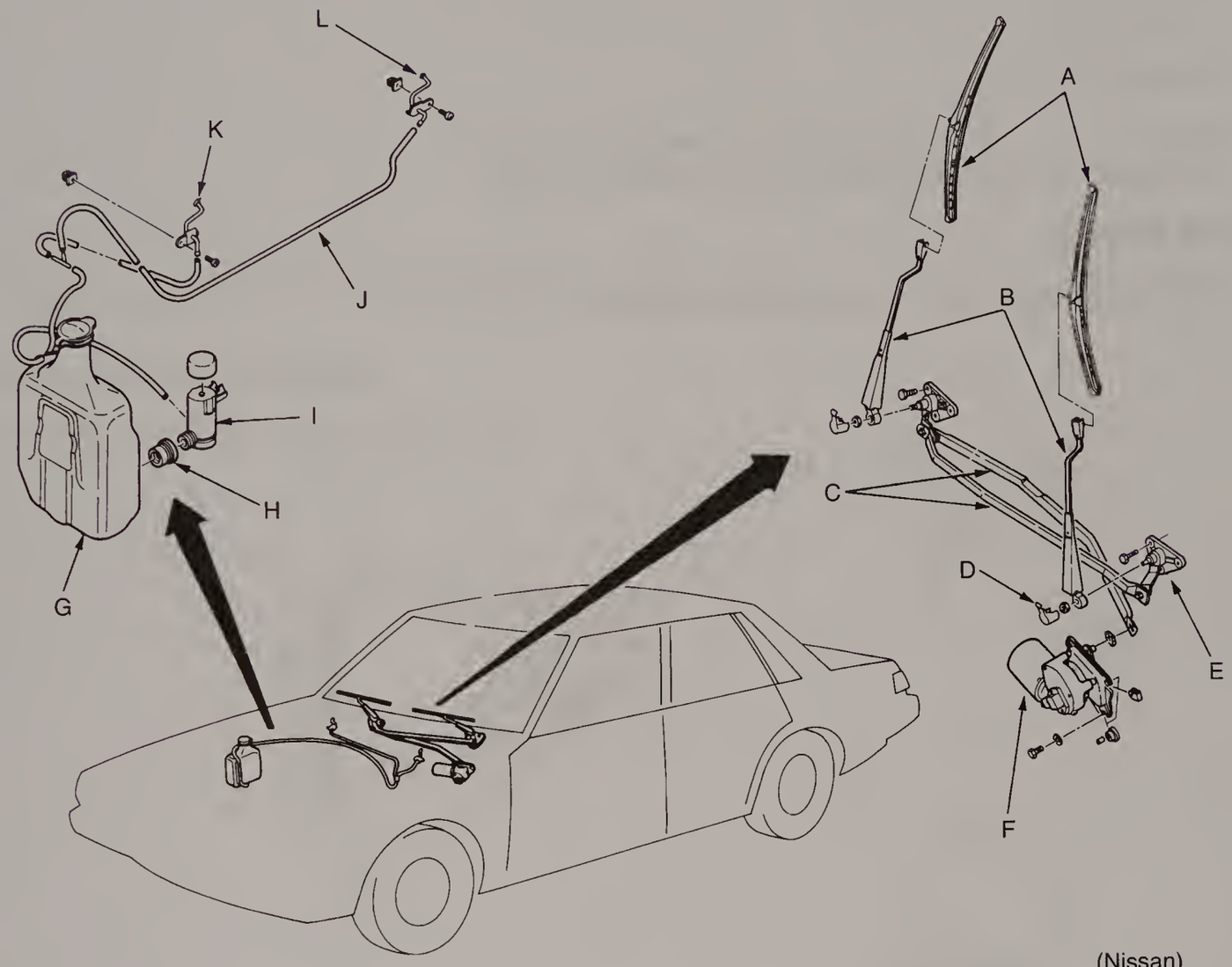
(General Motors)

3. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____
(Z) _____
(AA) _____

Name _____

Windshield Washer System

4. Identify the parts indicated on the diagram of the windshield washer system shown below.



(Nissan)

4. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

5. Which type of washer pump is used most often in windshield washer systems? 5. _____

   (A) Electric motor washer pump.

   (B) Mechanical washer pump.

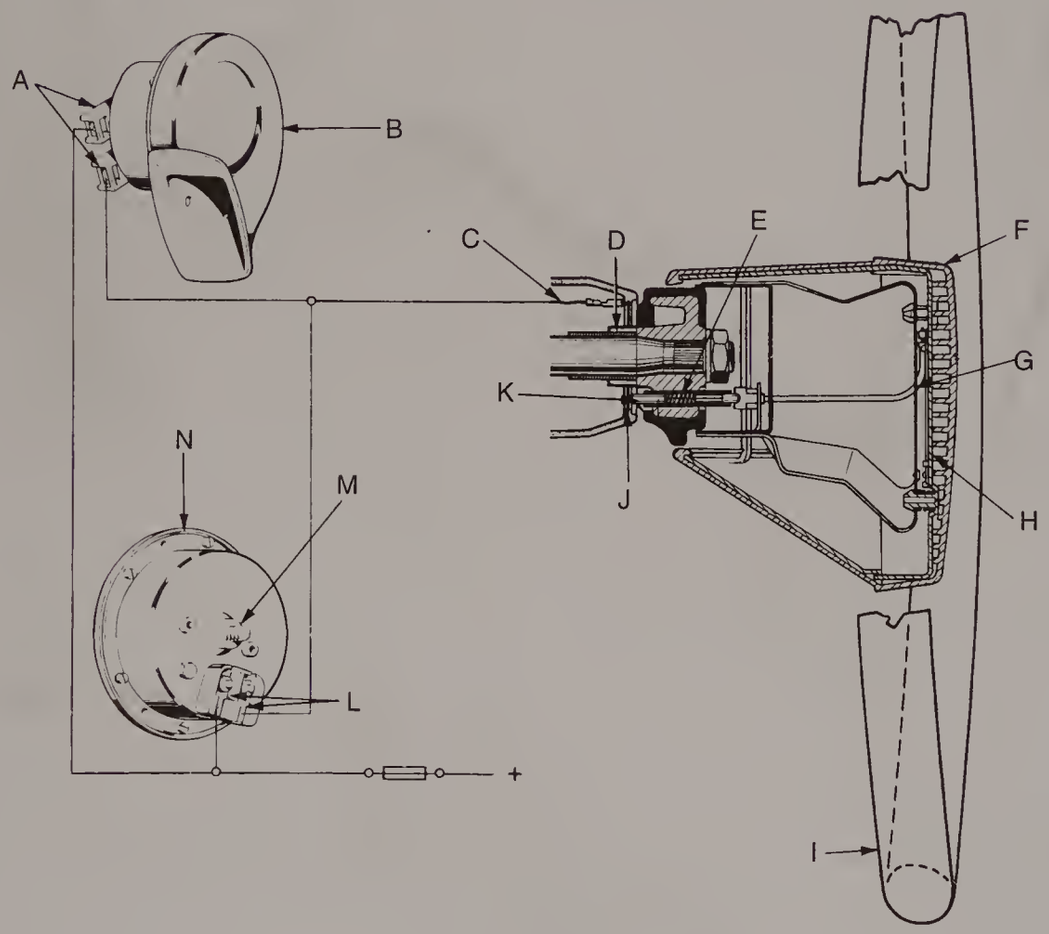
   (C) Reciprocating washer pump.

   (D) None of the above.

6. A(n) _____ _____ is commonly used to control the delay action in a windshield washer system with a pulse or delay wiper feature. 6. _____

Horn System

7. Identify the parts indicated on the horn system below.



(Saab)

7. (A) _____ (H) _____

   (B) _____ (I) _____

   (C) _____ (J) _____

   (D) _____ (K) _____

   (E) _____ (L) _____

   (F) _____ (M) _____

   (G) _____ (N) _____

Name _____

8. Name the parts that make up the internal structure of a typical horn.

_____

_____

_____

_____

_____

_____

9. A horn _____ is sometimes used between the horn switch and the horns to reduce the amount of current flowing through the horn switch. 9. _____

Theft Deterrent System

10. Explain how a theft deterrent system works.

_____

_____

_____

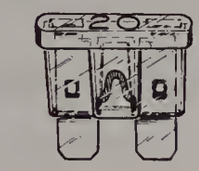
_____

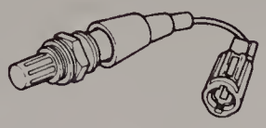
Name _____

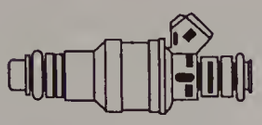
Date _____

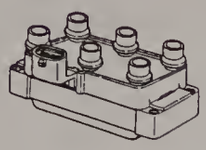
Instructor _____

Score _____ Text pages 325–336









Chapter 19

Seat, Window, Lock, Mirror, and Sound Systems

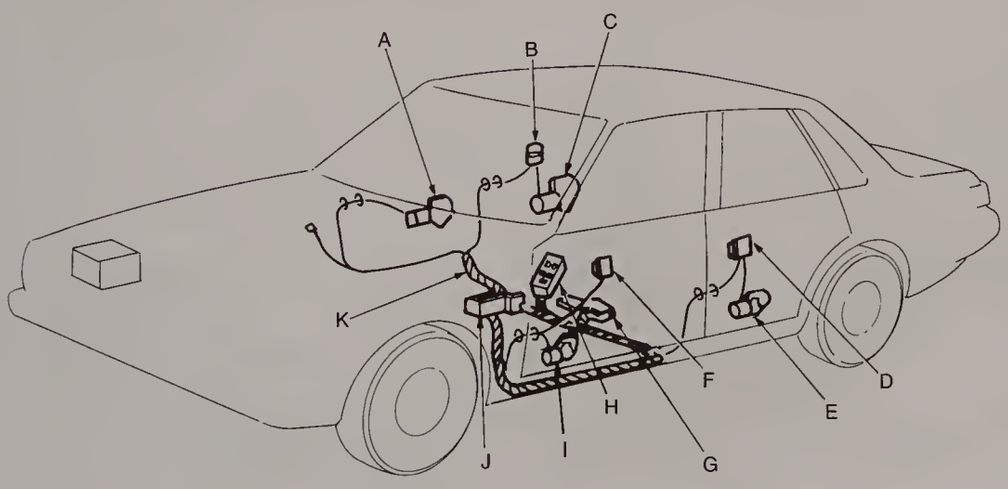
After studying this chapter and completing supplemental exercises, you will be able to:

- Summarize the parts of a power window system.
- Explain how power windows operate.
- Describe a power door lock system.
- Summarize the operation of power seats.
- Explain how memory seat positions are attained.
- Summarize the operation of a keyless entry system.
- Describe the construction and operation of an electric rear view mirror system.
- Explain the operation of a radio.
- List and describe the major parts of a sound system.
- Compare AM and FM signals.
- Explain tape player operation.
- Summarize compact disc operation.

Instructions: As you study Chapter 19 of the text, complete the following workbook problems in the spaces provided.

Power Windows

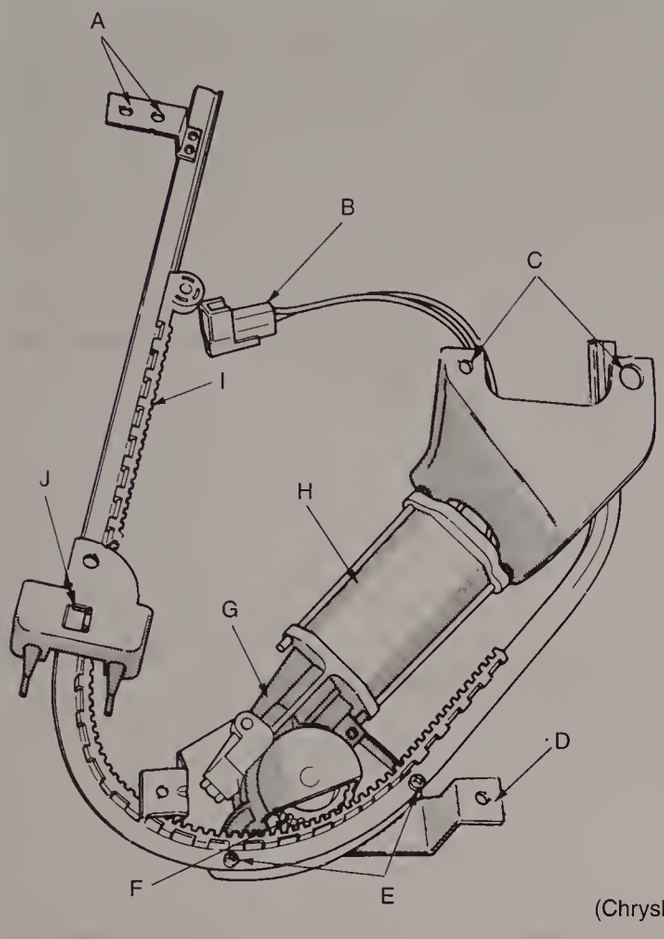
1. Identify the parts indicated on the diagram of the power window system shown below.



(Subaru)

1. (A) _____
   (B) _____
   (C) _____
   (D) _____
   (E) _____
   (F) _____
   (G) _____
   (H) _____
   (I) _____
   (J) _____
   (K) _____

2. Identify the parts indicated on the diagram below.

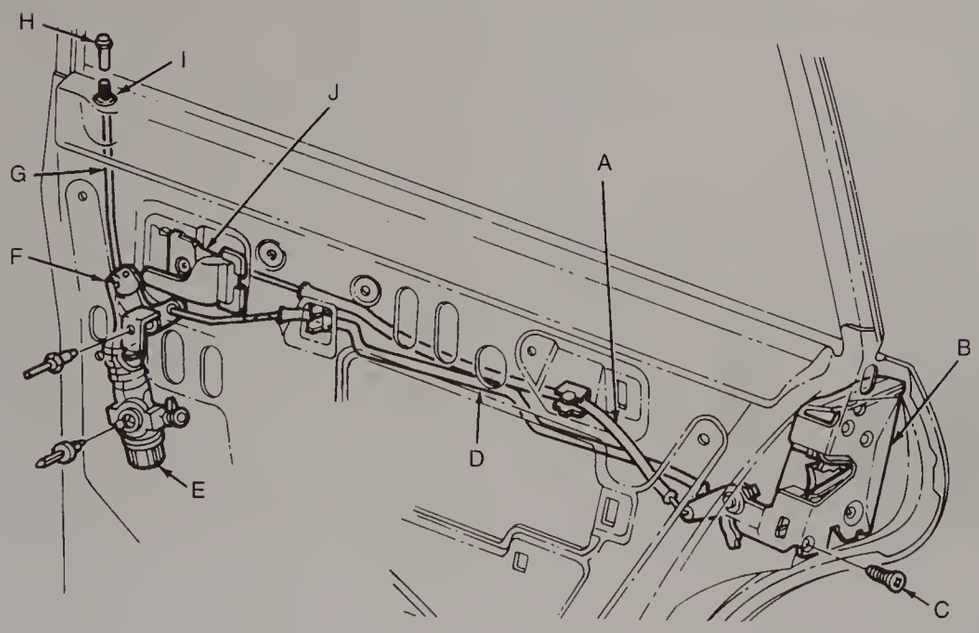


(Chrysler)

2. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

Power Door Locks

3. Identify the parts indicated on the diagram of the power door lock mechanism below.



(Ford)

3. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

Name _____

4. A(n) _____ entry system uses an input keyboard to send electrical data to a small processor or computer. 4. _____

Power Seats

5. A gearbox that changes rotating motion from motors and cables into linear motion for the seats is the description for which part of a power seat system? 5. _____

   (A) Seat track.

   (B) Seat transmission.

   (C) Seat drive cables.

   (D) Seat motors.

Power Mirrors

6. Identify the parts indicated on the power rear view mirror shown below. 6. (A) _____

   (B) _____

   (C) _____

   (D) _____

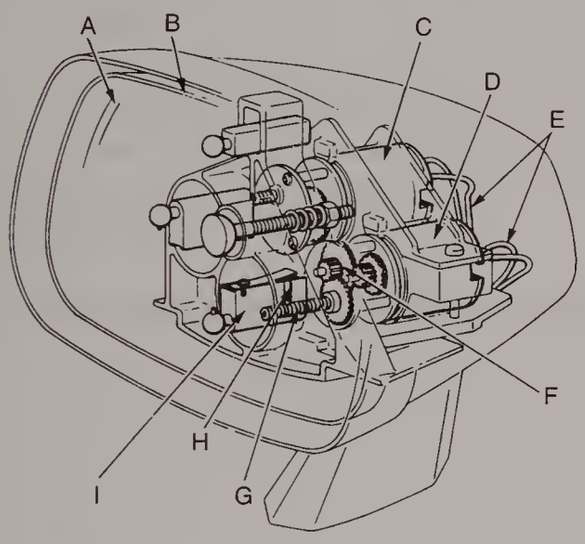
   (E) _____

   (F) _____

   (G) _____

   (H) _____

   (I) _____



(Chrysler)

Sound Systems

7. Identify the parts indicated on the diagram of the radio system shown below. 7. (A) _____

   (B) _____

   (C) _____

   (D) _____

   (E) _____

   (F) _____

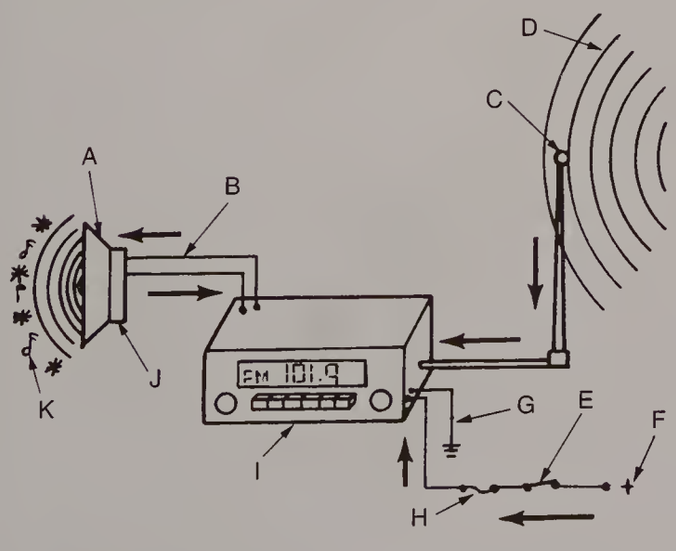
   (G) _____

   (H) _____

   (I) _____

   (J) _____

   (K) _____



8. Which type of antenna picks up both AM and FM signals? 8. _____

   (A) Mast antenna.

   (B) Antenna in glass.

   (C) Both (A) and (B).

   (D) None of the above.

9. A(n) _____ _____ is simply an electronic amplifier that increases the current output of the radio or tape player for driving the speakers more efficiently. 9. _____

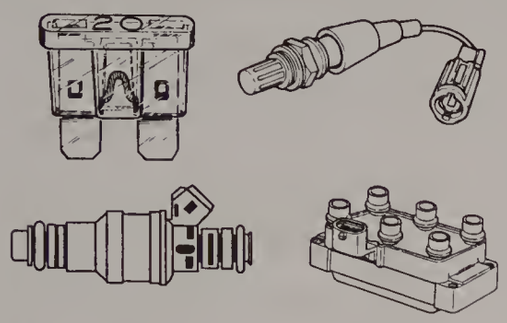
10. The electronic circuitry in the compact disc player changes the digital data into _____ outputs for driving the stereo speakers. 10. _____

Name _____

Date _____

Instructor _____

Score _____ Text pages 337–350



Chapter 20

Other Electronic Systems

After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the major parts of an anti-lock brake system.
- Summarize the operation of anti-lock brakes.
- Describe an electronic ride height control system.
- Explain an electronic shock absorber system.
- Summarize the parts and operation of an electronic climate control system.
- Explain the operation of a typical cruise control system.
- Describe the action and parts of an air bag system.
- Summarize the operation of an electronically controlled automatic transaxle.

Instructions: As you study Chapter 20 of the text, complete the following workbook problems in the spaces provided.

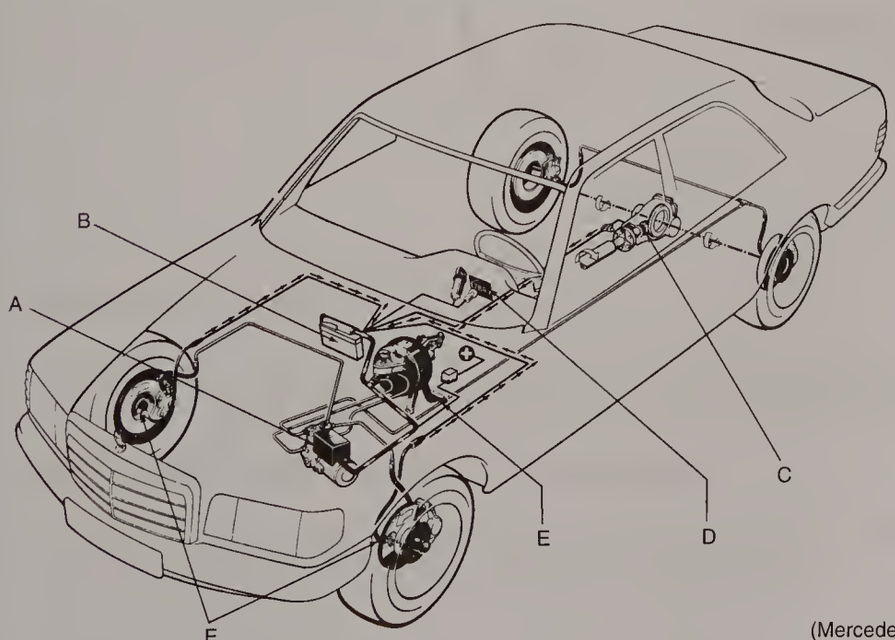
Anti-Lock Brake System (ABS)

1. Give two reasons the anti-lock brake system improves driver and passenger safety.

_____

_____

2. Identify the parts indicated in the diagram below.



(Mercedes Benz)

2. (A) _____

(B) _____

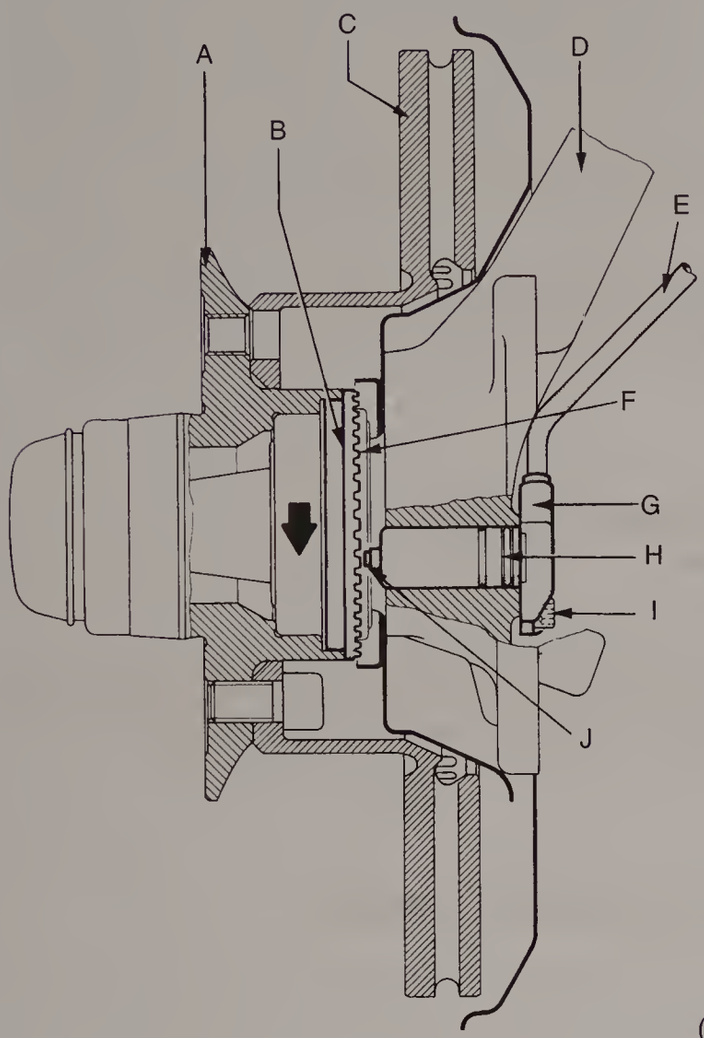
(C) _____

(D) _____

(E) _____

(F) _____

3. Identify the parts indicated on the diagram of the wheel speed sensor below.



(Mercedes Benz)

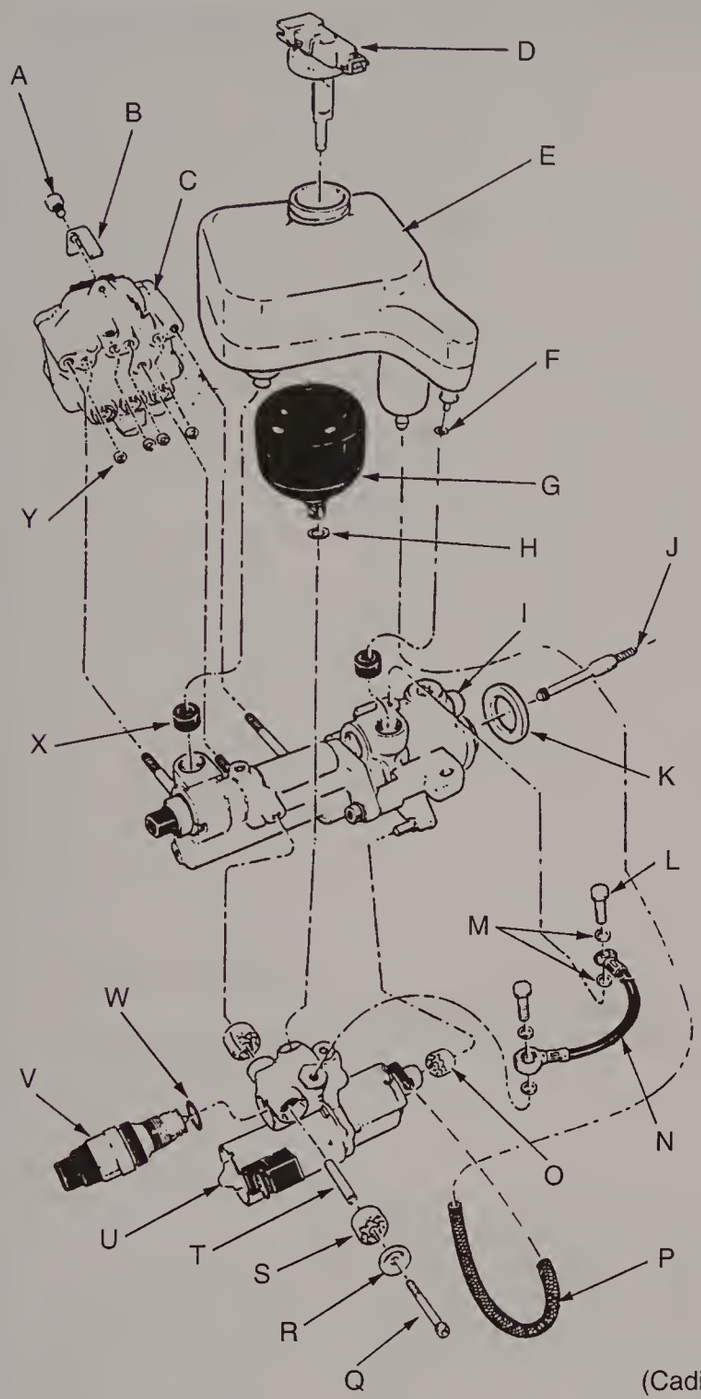
3. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

4. Under normal _____ , the ABS system is not used.

4. _____

Name _____

5. Identify the parts of the hydraulic actuator shown in the diagram below.



(Cadillac)

5. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____
(V) _____
(W) _____
(X) _____
(Y) _____

Electronic Height Control

6. The electronic height system is used on the rear of the car to _____ for loads placed in the trunk or when passengers fill the back seat.

6. _____

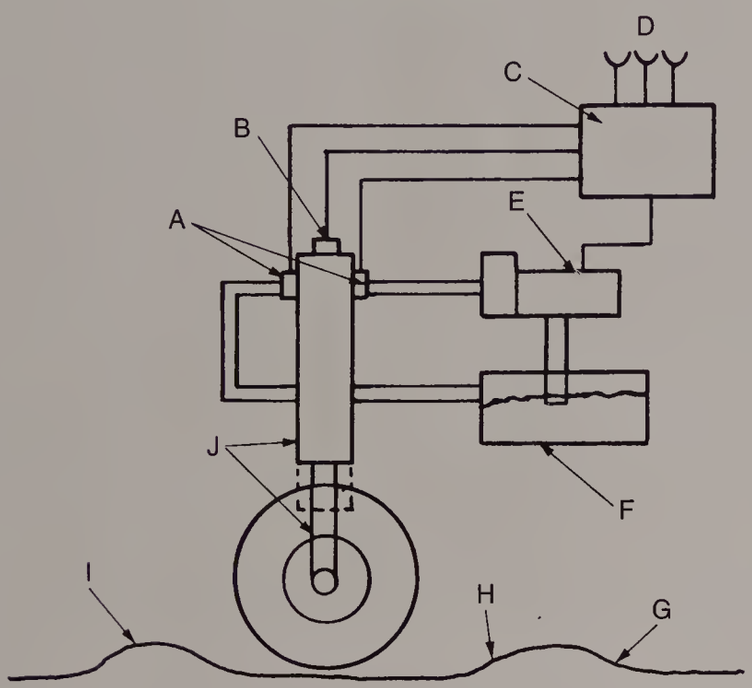
Electronic Shock Absorber System

7. In the electronic shock absorber system, the _____ can energize shock actuators to control ride stiffness and shock action.

7. _____

8. Identify the parts indicated on the diagram of the active suspension system shown below. Second, use arrows to indicate fluid flow.

ACTIVE SUSPENSION



8. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____

Electronic Climate Control

9. Name the six basic parts of an electronic climate control system and describe them.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

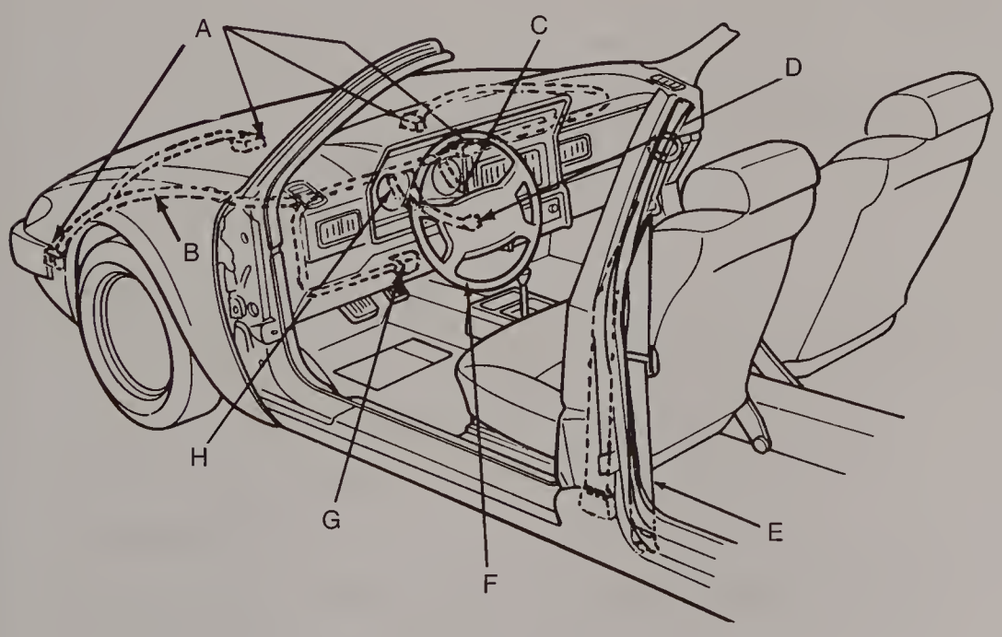
Name _____

Electronic Cruise Control System

10. Name the eight basic parts of an electronic cruise control system and describe them.

Air Bag System

11. Identify the various parts indicated on the diagram of the electronic air bag system shown here.



(Ford)

11. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

12. Explain why children and small adults should ride in the back seat whenever possible when riding in vehicles with passenger-side airbags.

_____

_____

Electronic Transmission/Transaxle Control

13. The electronic transmission/transaxle control system provides more efficient transmission operation, improving performance and increasing _____ _____. 13. _____

Electronic Four-Wheel Steering Systems

14. Electronic four-wheel steering systems contain: 14. _____

    (A) an electronic control unit.

    (B) steering angle sensors.

    (C) motor-driven gearsets.

    (D) All of the above.

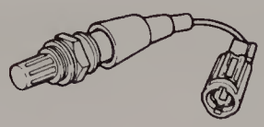
15. In an electronic four-wheel steering system, a mechanical link to the front rack-and-pinion gearbox prevents a total loss of _____ control. 15. _____

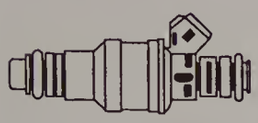
Name _____

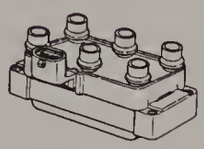
Date _____

Instructor _____

Score _____ Text pages 351–370







Chapter 21

On-Board Diagnostics, Scan Tools

After studying this chapter and completing supplemental exercises, you will be able to:

- Discuss the purpose and operation of on-board diagnostic systems.
- Explain the use of scan tools to simplify reading of trouble codes.
- Compare OBD I and OBD II system capabilities and procedures.
- Locate the data link connector on most makes and models of cars.
- Activate on-board diagnostics and read trouble codes with and without a scan tool.
- Use a trouble code chart in a service manual or code conversion by a scan tool.
- Erase diagnostic trouble codes.

Instructions: As you study Chapter 21 of the text, complete the following workbook problems in the spaces provided.

On-Board Diagnostic Systems

1. A vehicle computer's ability to analyze the operation of its circuits and to output data identifying any problems found is referred to as _____-_____ _____. 1. _____

2. A vehicle's engine control module can: 2. _____

   (A) detect engine misfiring and air-fuel mixture problems.

   (B) monitor the operation of the fuel injectors, ignition coils, fuel pump, emission system parts, and other major components.

   (C) scan for problems in the engine and its support systems, the transmission, the suspension system, the anti-lock brake system, and other vehicle systems.

   (D) All of the above.

3. OBD I diagnostic systems: 3. _____

   (A) simply store a code and illuminate a dash light once a sensor or circuit stops working completely.

   (B) are used in millions of vehicles on the road.

   (C) Both (A) and (B) above.

   (D) None of the above.

4. OBD II diagnostics detect part _____, not just complete part failure. 4. _____

5. Describe the differences between the on-board computers used in the OBD II and OBD I systems.

_____

_____

_____

6. A flashing MIL (malfunction indicator light) indicates that the: 6. _____

(A) trouble is not critical, but should be repaired.

(B) problem may be intermittent.

(C) trouble could damage the catalytic converter and is, therefore, considered critical.

(D) None of the above.

7. Digital signals produced and stored by the computer when an operator parameter is exceeded are called _____ _____ _____. 7. _____

8. List at least ten common problems that can affect vehicle performance and cause the computer system to set a code and light the MIL in the dash.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

9. Only about _____% of all performance problems are caused by an actual fault in the computer or one of its sensors. 9. _____

(A) 10

(B) 20

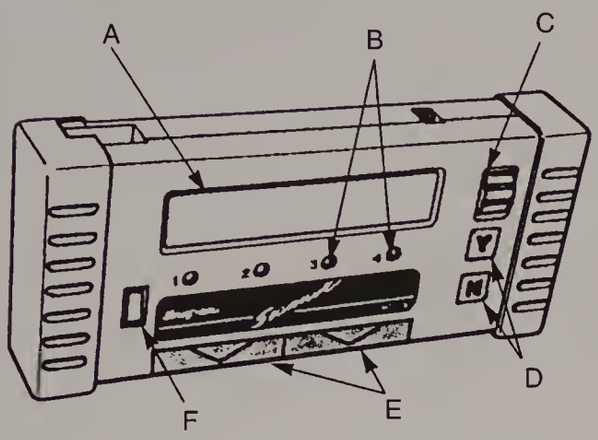
(C) 60

(D) 80

Name _____

Scanning Computer Problems

10. Identify the parts indicated on the scan tool below.



10. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____

11. Why should you avoid touching the cartridge or scan tool terminals?

_____

_____

12. List five common locations for the diagnostic connector. Second, place a check next to the standard OBD II location.

_____

_____

_____

_____

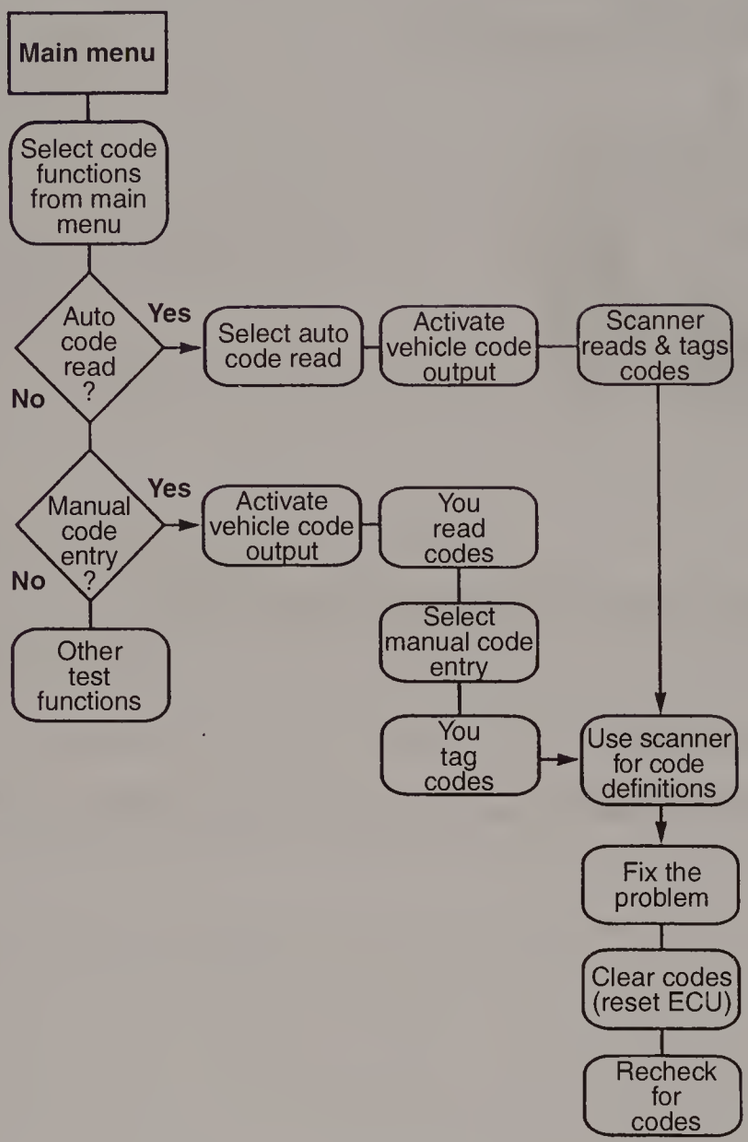
_____

13. What does the VIN data let the scan tool know?

_____

_____

14. What does the following diagram show?



(Snap-On Tools)

15. Why should you always correct the cause of the lowest number diagnostic trouble code first?

16. OBD II codes contain a letter and a four-digit number. What do each of the following indicate?

The letter: _____

The first digit: _____

Name _____

The second digit: _____

_____

The last two digits: _____

_____

17. List and describe the four general categories of computer system failure.

_____

_____

_____

_____

_____

_____

_____

_____

18. Explain how to perform a wiggle test.

_____

_____

_____

_____

_____

_____

19. What does a switch diagnostic test involve?

_____

Energizing OBD I Systems Without a Scan Tool

20. Suppose you do not have a scan tool and are working on an OBD I-equipped vehicle. Name the four most common methods you could use to activate the computer's on-board diagnostics to retrieve trouble codes.

_____

_____

_____

_____

_____

_____

_____

_____

21. List the five most typical methods of reading trouble codes on older vehicles.

22. Explain why you should use only a high-impedance (10 meg-ohms or higher) test light or multimeter when testing computer circuits.

Erasing Trouble Codes

23. Explain why trouble codes should be erased after system repairs have been made.

24. List three ways often used to erase trouble codes from the computer.

25. A(n) _____ _____ could damage the computer if the technician unplugs or plugs in the computer harness connector with the ignition key on or the engine running. 25. _____

Name _____

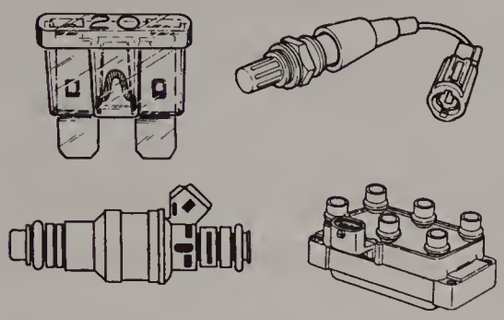
Date _____

Instructor _____

Score _____ Text pages 371–394

Chapter 22

Sensor, Actuator, Computer Service



After studying this chapter and completing supplemental exercises, you will be able to:

- Explain the preliminary inspections that should be done when troubleshooting computer system malfunctions.
- Describe why remembering basic tests and problems is important to working on cars with computer controls.
- Use a breakout box to make electrical measurements and tests.
- Test various voltage generating sensors.
- Test variable resistance and switching type sensors. Use specialized sensor testers.
- Service an oxygen sensor.
- Adjust a throttle position sensor.
- Properly remove and replace various sensors.
- Test servo motors, solenoids, injectors, electric fuel pumps, and other types of actuators.
- Remove and replace a computer PROM.
- Measure computer reference voltage output to sensors with a VOM and computer signals to a mixture control solenoid with a dwell meter.
- Remove and replace a computer.

Instructions: As you study Chapter 22 of the text, complete the following workbook problems in the spaces provided.

Preliminary Inspection

1. What is the cipet principle and what does the term *cipet* represent?

_____

_____

C: _____

I: _____

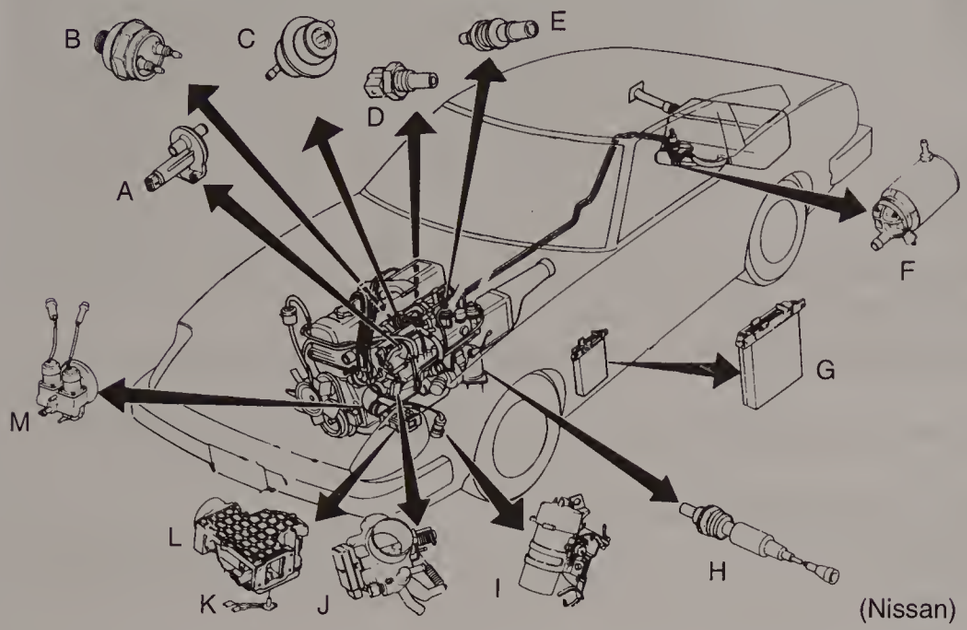
P: _____

E: _____

T: _____

Sensor Service

2. Identify the sensors and actuators indicated on the diagram below.



(Nissan)

2. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____

3. Poor electrical _____ are the most common cause of electrical related problems in a computer system. 3. _____

4. _____ leaks can cause a wide range of problems, many of which can appear to be computer related. 4. _____

Sensor Problems, Testing, Replacement

5. Which of the following sensors requires a digital meter for testing? 5. _____

   (A) Ohmmeter.

   (B) Voltmeter.

   (C) Voltage generating sensor.

   (D) None of the above.

6. List seven things to remember to avoid electrical component damage when working with semiconductor devices and their wiring.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Name _____

7. A reference voltage of typically _____ volts is fed to switching and variable resistance type sensors. 7. _____

8. An engine can be kept from running if a bad engine speed sensor disables the _____ system. 8. _____

9. A bad vehicle _____ sensor will usually reduce engine performance and fuel economy but will not normally keep the engine from running. 9. _____

10. Name three causes of oxygen sensor contamination.

_____

_____

_____

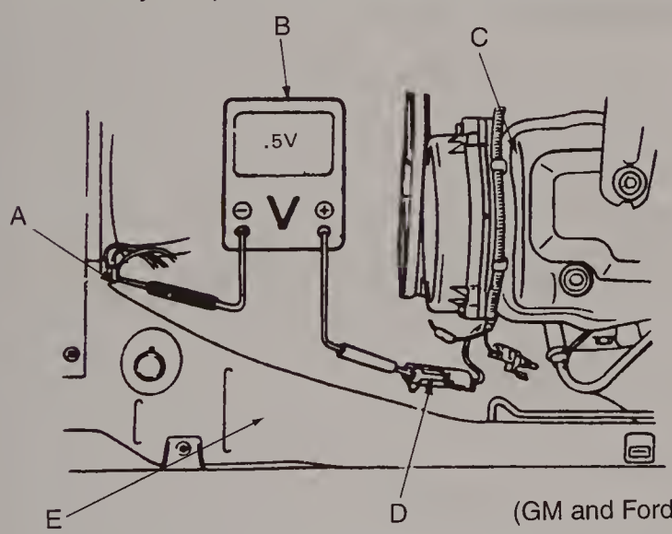
11. Explain why you should not use a conventional analog or low resistance meter to measure oxygen sensor voltage.

_____

_____

12. Identify the parts indicated on the diagram below.

12. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____



(GM and Ford)

13. List 10 rules to follow when replacing an oxygen sensor.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

14. When reading an oxygen sensor, which tip color is a normal color for an oxygen sensor? 14. _____

    (A) Light gray.

    (B) White.

    (C) Tan.

    (D) Black.

15. Describe how to test a manifold pressure sensor.

_____

_____

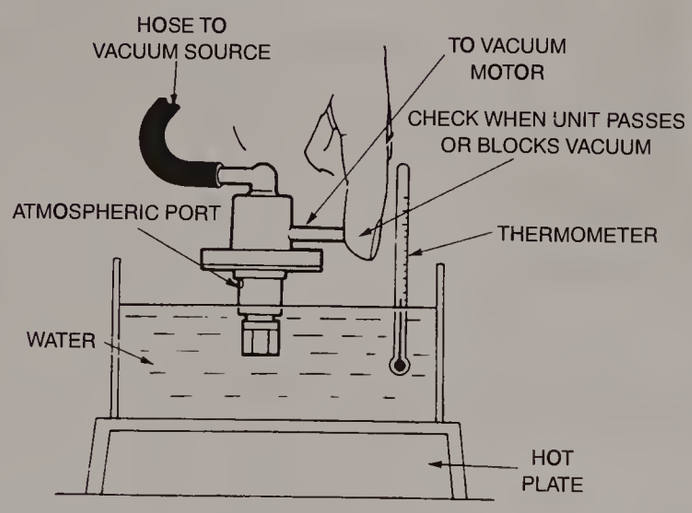
_____

16. When the gas pedal is depressed to different positions for acceleration, deceleration, idle, cruise, and full power, a(n) _____ _____ sensor signals the computer. 16. _____

17. In order to test the idle switch, a(n) _____ is commonly recommended. 17. _____

18. The _____ sensor richens the air-fuel ratio when cold and leans the mixture when hot. 18. _____

19. Describe what is happening in the diagram below.



(General Motors)

_____

_____

20. Explain why you should make sure the fuel tank is almost empty before removing the fuel sending unit.

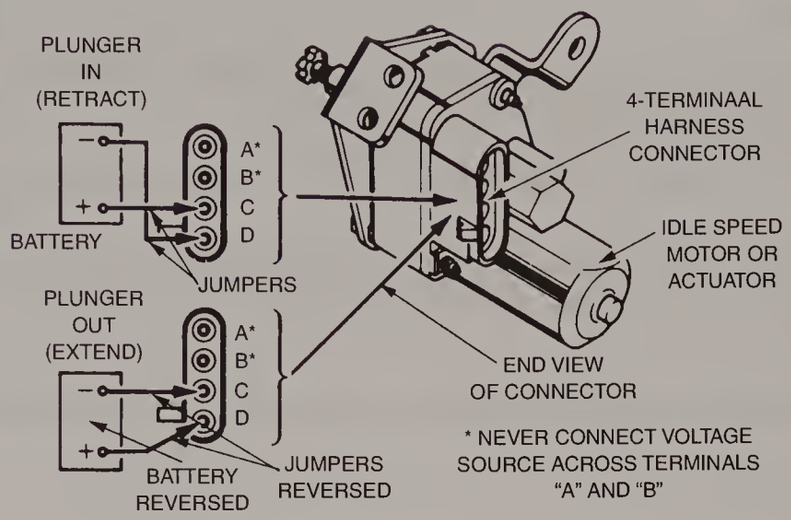
_____

_____

Name _____

Actuator Service

21. Describe what is happening in the diagram below.



(GM)

_____

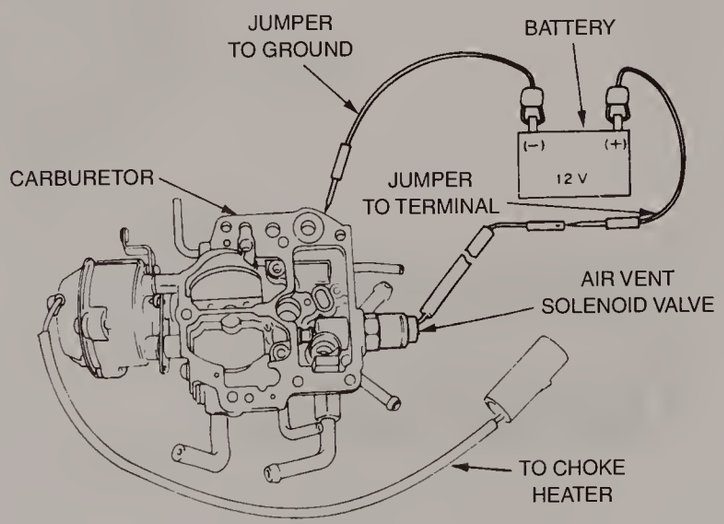
_____

22. Describe how to check the idle air control valve.

_____

_____

23. What is happening in the diagram below?



(GM)

_____

_____

24. During testing of the mixture control solenoid, when voltage is applied, the unit should hold _____ . 24. _____

Computer Service

25. Only after all other potential sources of troubles have been eliminated, is the _____ suspected of being the source of car problems. 25. _____

26. To make sure the correct reference voltage is being sent to a sensor, use a(n) _____. 26. _____

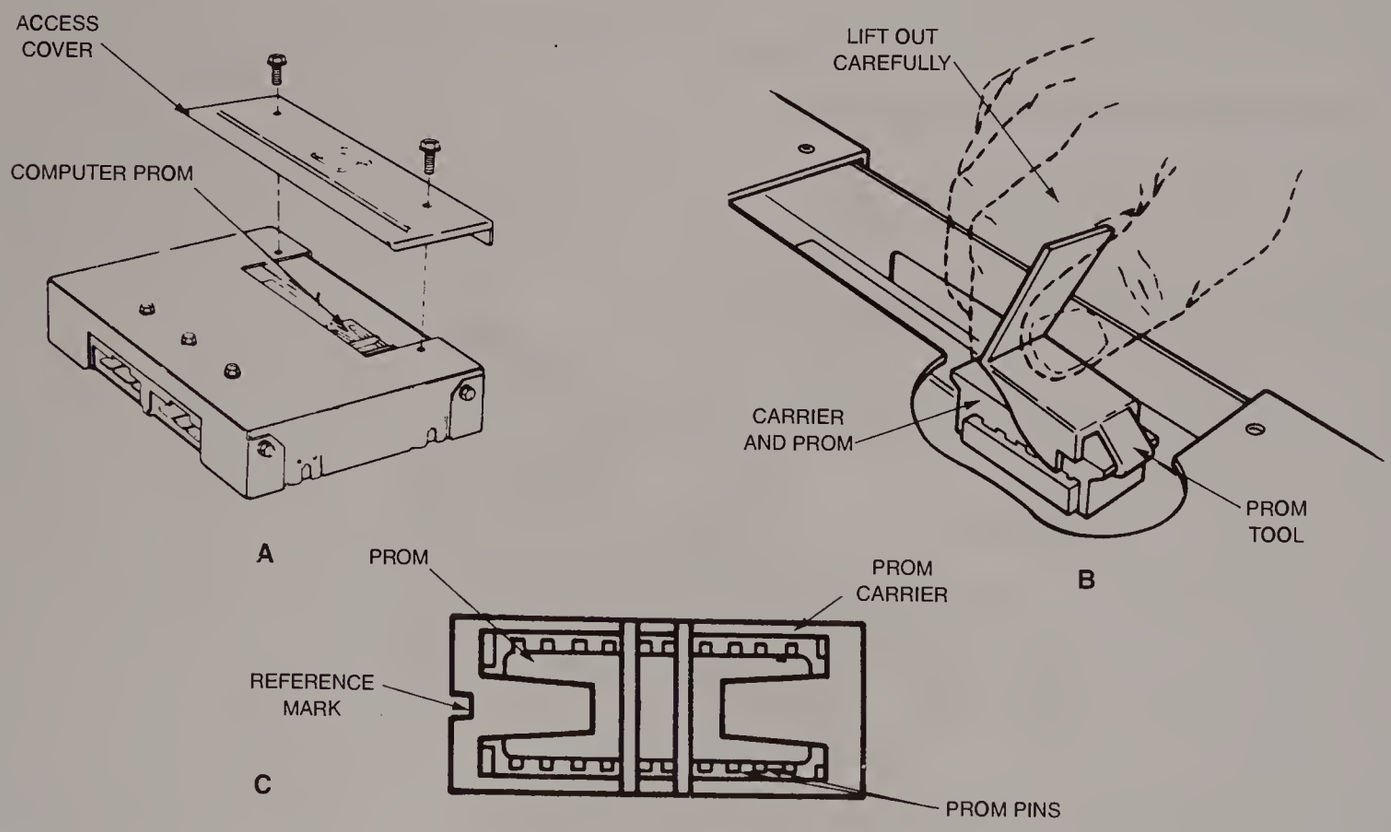
27. Saving memory can be done by connecting small batteries across the two battery cables _____ (after, before) the car battery is disconnected. 27. _____

28. Explain why the ignition key should be off and the car battery disconnected when removing a computer.

_____

_____

29. Describe what is being done in each of the diagrams below.



29. (A) _____

_____

(B) _____

_____

(C) _____

_____

Name _____

30. If you install PROM backwards, it: 30. _____

(A) will usually require replacement because of damage.

(B) will have no effect.

(C) will cause serious damage to the computer.

(D) None of the above.

31. _____ can be reprogrammed in order to correct driveability and performance problems. 31. _____

32. List three methods of programming an EEPROM.

_____

_____

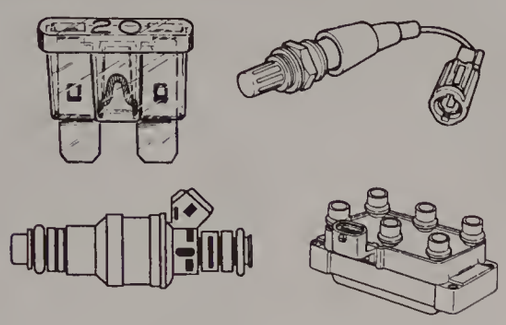
_____

Name _____

Date _____

Instructor _____

Score _____ Text pages 395–418



Chapter 23

Battery and Starting System Service

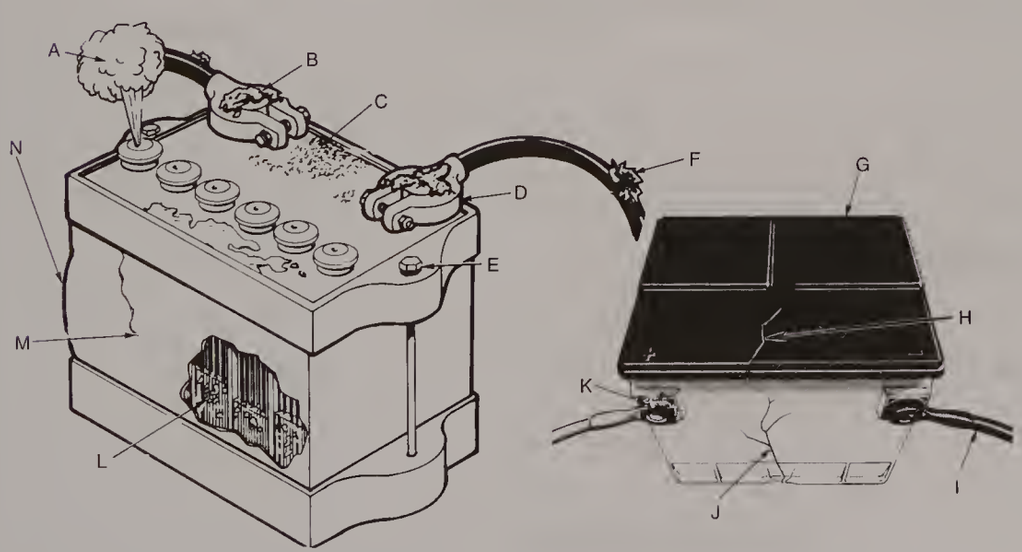
After studying this chapter and completing supplemental exercises, you will be able to:

- Troubleshoot battery problems.
- Test and service a battery.
- Use a load tester.
- Test battery cables.
- Troubleshoot starting system problems.
- Test a starting system.
- Remove and replace a starting motor.
- Rebuild a starting motor.
- Test and replace a starter solenoid.
- Use jumper cables and a battery charger.

Instructions: As you study Chapter 23 of the text, complete the following workbook problems in the spaces provided.

Battery Service

1. Identify various battery troubles that can cause a discharged or "dead" battery.



(Florida Dept. of Voc. Ed. and Sun Electric)

1. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____

2. When inspecting a battery, one possible problem is a rusted or missing _____ _____. 2. _____

3. A(n) _____ _____ test is done to determine if current is discharging across the top of a dirty battery case. 3. _____

   (A) battery load

   (B) battery terminal

   (C) battery leakage

   (D) Both (A) and (C).

4. A(n) _____ load includes any current draw present when all electrical/electronic devices are shut off. 4. _____

5. A(n) _____ _____ test is used to check for a poor electrical connection between the battery cables and terminals. 5. _____

   (A) battery voltage

   (B) battery terminal

   (C) battery leakage

   (D) None of the above.

Battery Maintenance

6. List five battery maintenance steps.

_____

_____

_____

_____

_____

7. Why is it necessary to wear eye protection when working around batteries?

_____

_____

_____

8. If the top of the battery is dirty, wash it down with: 8. _____

   (A) baking soda and water.

   (B) vinegar.

   (C) soap and water.

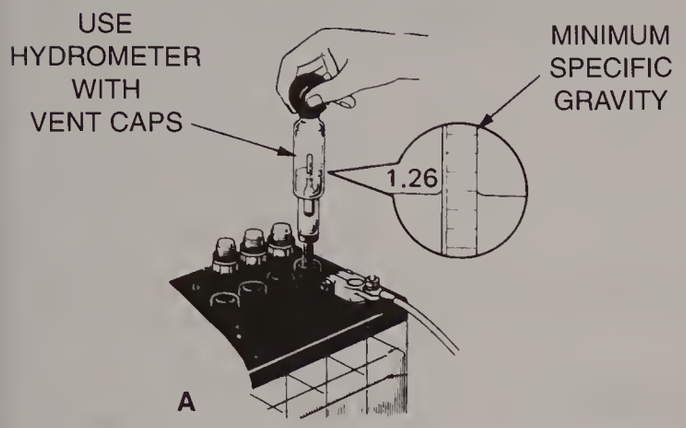
   (D) Either (A) or (C).

9. Under normal conditions, a(n) _____ -_____ battery does not need periodic electrolyte service. 9. _____

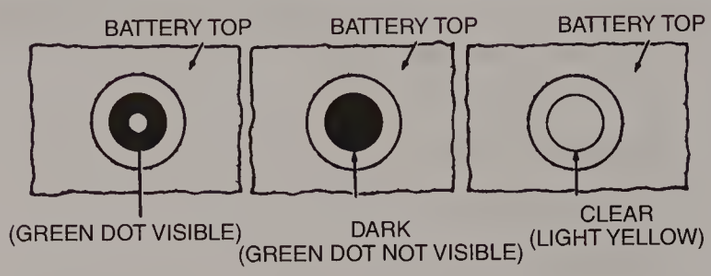
Name _____

Checking Battery Charge

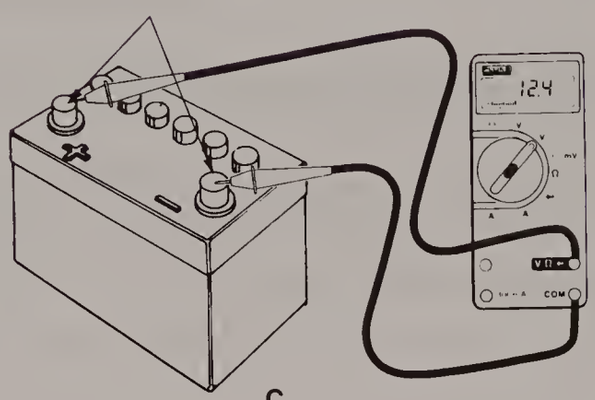
10. Identify the various methods of checking the state of battery charge below.



A



B



C

(Toyota, GM, and Fluke)

10. (A) _____

(B) _____

(C) _____

11. Name six causes of a discharged battery.

_____

_____

_____

_____

_____

_____

Battery Voltage Test

12. A well charged battery should have over _____ volts. 12. _____

13. A(n) _____ _____ test will let you know if the battery is defective or just discharged. 13. _____

    (A) cell voltage

    (B) battery capacity

    (C) quick charge

    (D) battery drain

Jump Starting

14. When jump starting a battery, two batteries are connected positive to _____ (negative, positive) and negative to negative. 14. _____

Battery Chargers

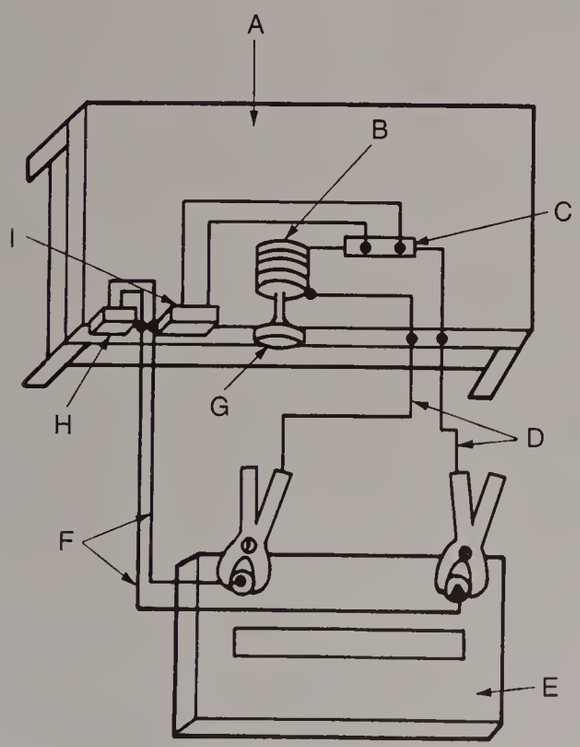
15. The battery charger will force current back into the battery to restore the charge on the battery plates and in the _____. 15. _____

16. Rapid battery recharging is accomplished by using a(n) _____ charger, which forces high current flow into the battery. 16. _____

17. Before connecting a battery charger to a battery, make sure the charger is turned _____ (off, on). 17. _____

Battery Load Test

18. Identify the parts indicated on the diagram of the load tester below.



18. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(I) _____

Name _____

19. If a load tester is not _____ , you must connect the ammeter in series. 19. _____

20. A battery must be adequately _____ before conducting a load test. 20. _____

21. A battery with 500 cold cranking amps should be loaded to: 21. _____

(A) 100 amps.

(B) 250 amps.

(C) 500 amps.

(D) 1000 amps.

22. If the voltmeter reads _____ volts or more at room temperature, the battery power is acceptable. 22. _____

23. A quick (3-minute) charge test is used to determine if the battery is _____. 23. _____

Other Battery-Related Problems

24. If the battery passes all of its tests, but the battery does not perform properly, one problem to check for is a loose _____ _____. 24. _____

Removing and Replacing a Battery

25. A replacement battery should have a(n) _____ _____ equal to factory recommendations. 25. _____

26. A battery _____ test is used to check for an abnormal current draw with the ignition key off. 26. _____

Starting System Diagnosis

27. A buzzing or clicking sound from the solenoid without cranking is commonly due to: 27. _____

(A) a bad starter.

(B) a discharged battery or poor battery cable connections.

(C) a broken or worn flywheel.

(D) None of the above.

28. When performing a starting headlight test, if the lights go out when cranking: 28. _____

(A) the battery is dead.

(B) there may be high resistance in the starting circuit.

(C) the battery may be weak.

(D) None of the above.

Starter Current Draw Test

29. What could happen if the engine were cranked for more than 15-30 seconds?

_____

Starting System Voltage Drop Tests

30. When checking circuit condition, you do not have to disconnect wires and components to check _____ _____ (voltage drops). 30. _____

31. A test which checks all parts between the battery positive and the starting motor for excess resistance is a(n) _____ _____ _____ test. 31. _____

32. A(n) _____ _____ _____ test is done to check the circuit between the starting motor ground and the negative battery terminal. 32. _____

Battery Cable Problems

33. How are battery or starter cables tested?

_____

_____

34. When replacing battery cables, cables with _____ (lead, steel) terminals are preferred. 34. _____

Starter Solenoid Service

35. A(n) _____ _____ test will quickly check the condition of solenoid and its electrical connections. 35. _____

Ignition Switch Service

36. The starter solenoid can be kept from _____ by a faulty ignition switch. 36. _____

37. If the test light on the solenoid does not glow, either a wire in the ignition switch circuit is open or the ignition switch is _____. 37. _____

Starter Relay Service

38. To test a starter relay, use a test light or VOM to check for voltage going into and coming out of the _____ _____. 38. _____

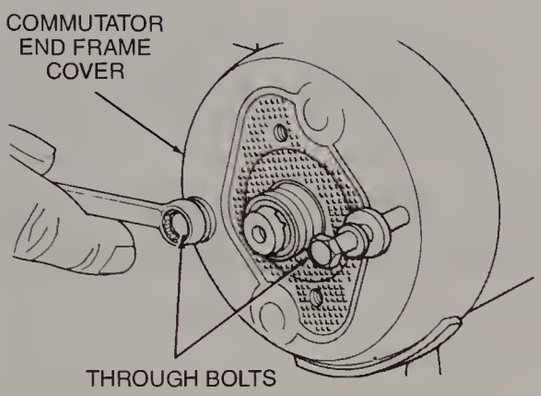
Neutral Safety Switch Service

39. If the neutral safety switch is open, current cannot flow from the ignition switch to the _____ _____. 39. _____

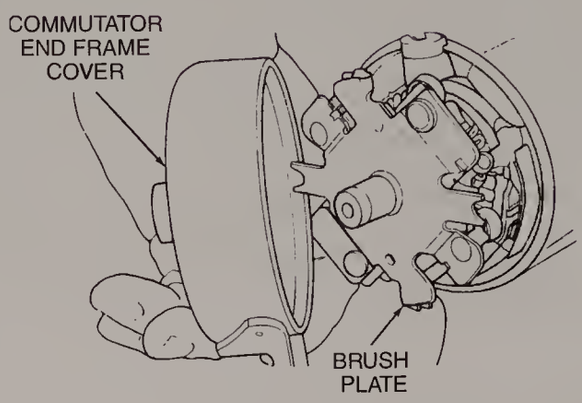
Name _____

Starter Service

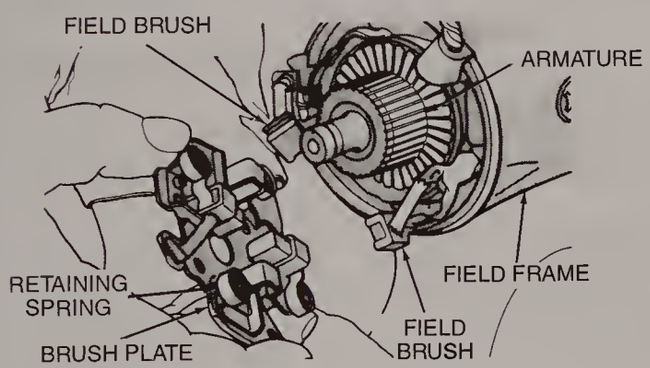
40. The basic steps involved in starter disassembly are illustrated below. Label them.



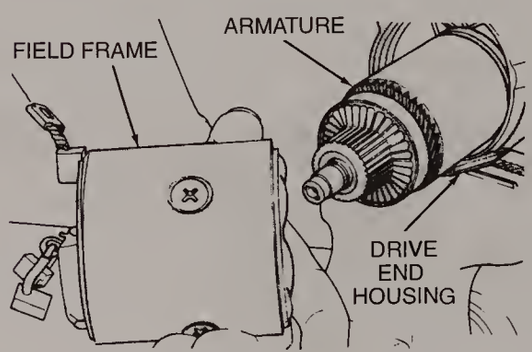
(A) _____



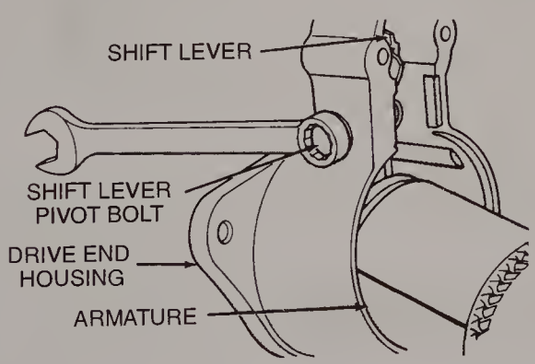
(B) _____



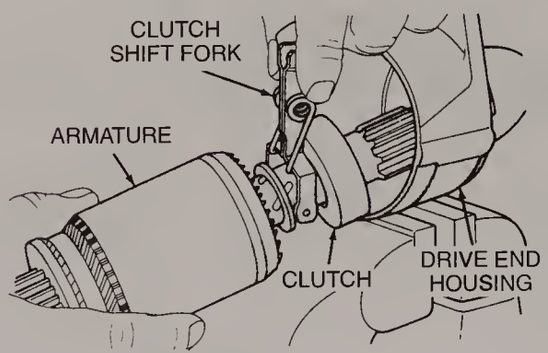
(C) _____



(D) _____



(E) _____



(F) _____

41. Do a(n) _____ _____ test to check armature continuity. 41. _____

42. When the test light does not glow or the meter reads infinite resistance, the field windings are open and must be: 42. _____

(A) replaced.

(B) repaired.

(C) ignored.

(D) None of the above.

43. It is usually wise to replace the _____ gear during starter service. 43. _____

44. Explain why it is important not to use too much oil or grease to lubricate the bushings and other parts of a starting motor.

_____

_____

_____

45. Why is it necessary that any spacer shims are replaced between the motor and the engine block?

_____

_____

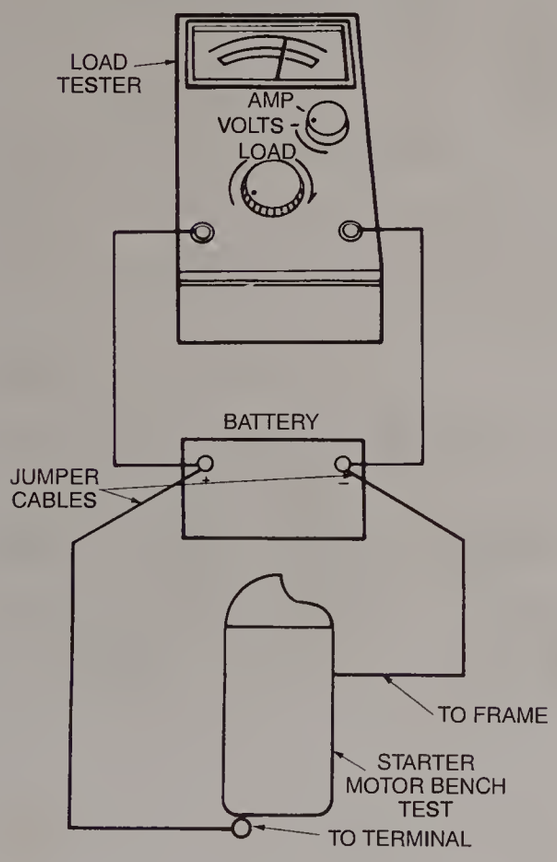
46. Describe what is being done in the diagrams of the installation of a starting motor after rebuilding.

46. (A) _____

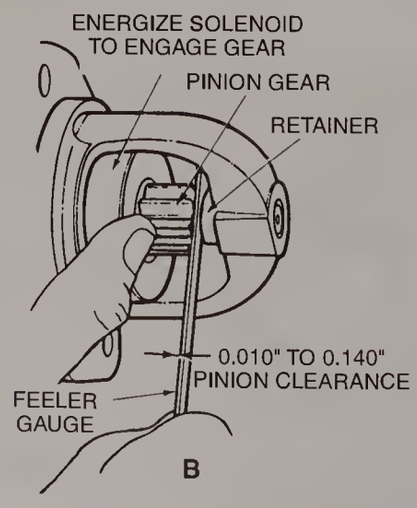
_____

(B) _____

_____



A



B

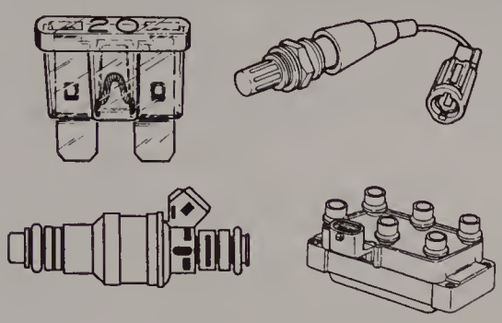
(Ford and GM)

Name _____

Date _____

Instructor _____

Score _____ Text pages 419–436



Chapter 24

Charging System Diagnosis and Repair

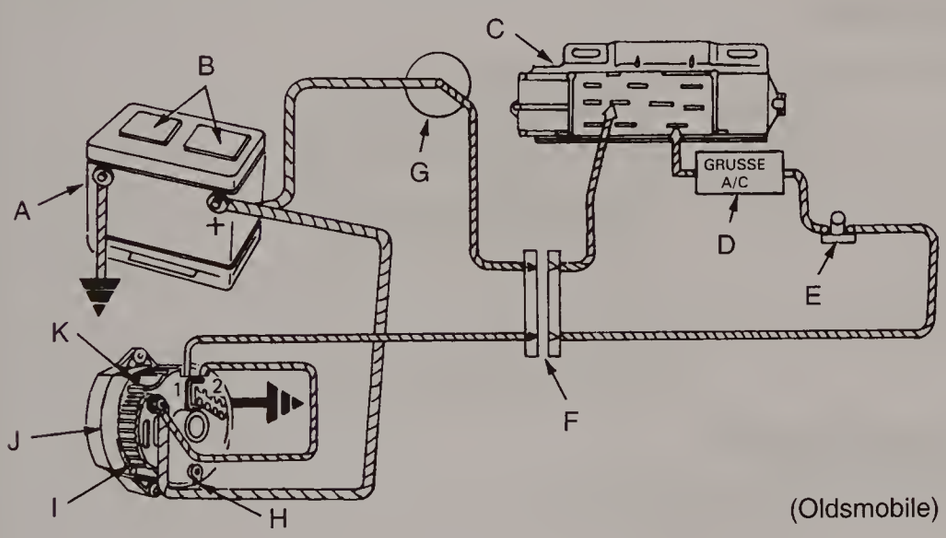
After studying this chapter and completing supplemental exercises, you will be able to:

- Troubleshoot problems in a charging system.
- Test the voltage output of a charging system with a VOM and a load tester.
- Bypass the regulator to isolate a charging system problem.
- Remove and replace an alternator.
- Remove and replace a voltage regulator.
- Rebuild an alternator.

Instructions: As you study Chapter 24 of the text, complete the following workbook problems in the spaces provided.

Charging System Diagnosis

1. Look at the diagram below. Identify the problems that can affect or appear to affect the operation of a charging system.



(Oldsmobile)

1. (A) _____
   (B) _____
   (C) _____
   (D) _____
   (E) _____
   (F) _____
   (G) _____
   (H) _____
   (I) _____
   (J) _____
   (K) _____

2. All of the following are types of symptoms caused by charging system problems EXCEPT:

   (A) Dead battery.

   (B) Vacuum leak.

   (C) Overcharged battery.

   (D) Abnormal noises.

2. _____

3. Explain why an alternator belt should only be tightened enough to prevent belt slippage or flap.

Charging System Precautions

4. Precautions should be taken when working on a charging system to help prevent possible damage to the charging and other _____ systems. 4. _____

Charging System Tests

5. Name and describe four charging system tests.

Voltmeter Test of Charging Output

6. Identify the basic steps of using VOM to check the condition of a charging system.

7. A voltmeter _____ test should be performed following a voltmeter no-load test. 7. _____

Load Tester Check of Charging System

8. A charging system _____ test measures system current and voltage under maximum load. 8. _____

9. Explain how to calculate charging system output.

10. To check the calibration of the voltage regulator and detect a high or low voltage setting, a(n) _____ voltage test is used. 10. _____

Name _____

11. A(n) _____ _____ test is a quick and easy way of finding out if the alternator, regulator, or circuit is faulty. 11. _____

    (A) regulator bypass

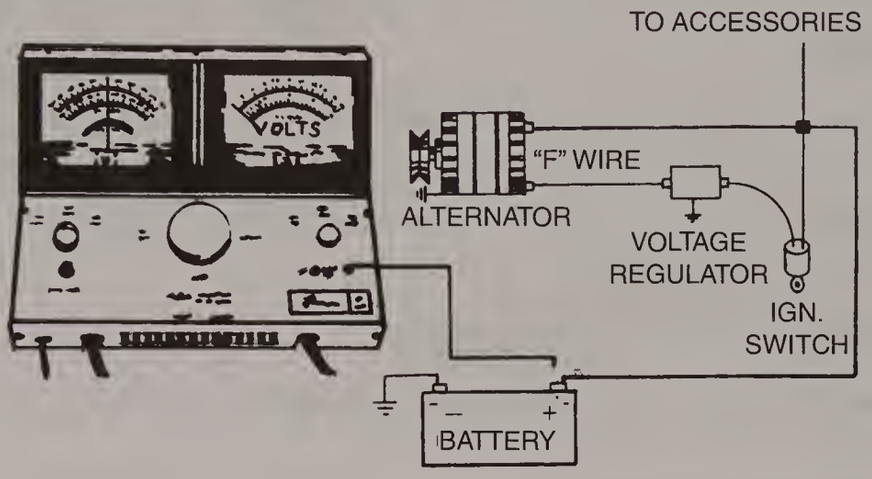
    (B) regulator voltage

    (C) circuit resistance

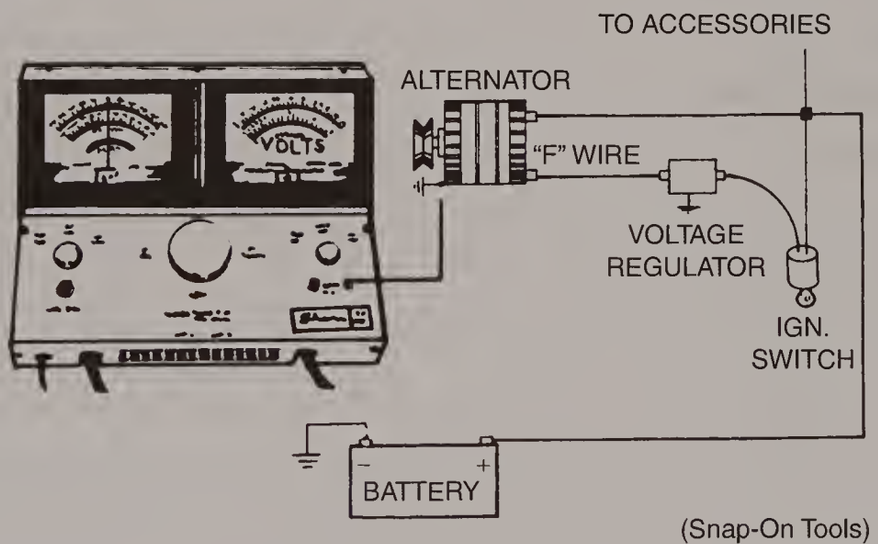
    (D) None of the above.

12. If charging voltage and current increase to normal levels when the regulator is bypassed, you usually have a _____ (bad, good) regulator. 12. _____

13. Identify the voltage drop or resistance tests shown below.



(A) _____



(Snap-On Tools)

(B) _____

Alternator Service

14. To prevent damage to parts if wires are shorted, disconnect the _____ before unbolting the alternator. 14. _____

15. When disassembling an alternator, why should you scribe marks on the outside of the housing? 15. _____

16. Which of the following checks the windings for internal shorts? 16. _____

    (A) Rotor winding open circuit test.

    (B) Rotor winding short-to-ground test.

    (C) Rotor current test.

    (D) None of the above.

17. What is the most common way to test alternator diodes? 17. _____

    (A) Test light.

    (B) Scope.

    (C) Ohmmeter.

    (D) Special diode tester.

18. When rebuilding an alternator, it is common practice to replace the alternator _____ . 18. _____

19. When brushes are worn beyond specs: 19. _____

    (A) repair them.

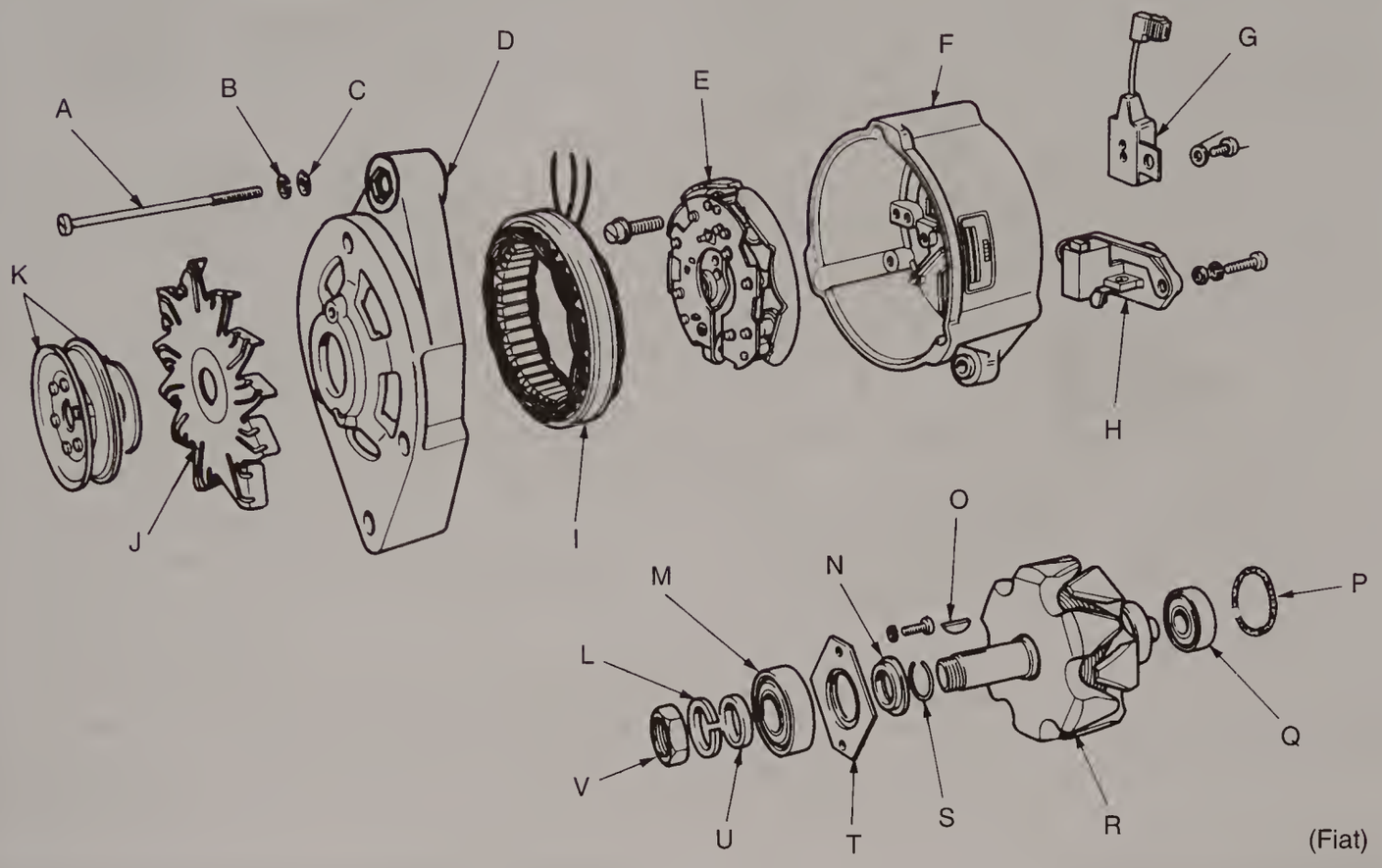
    (B) replace them.

    (C) soak them in oil or grease.

    (D) None of the above.

Name _____

20. Identify the parts of the alternator shown below.



(Fiat)

(A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(I) _____

(J) _____

(K) _____

(L) _____

(M) _____

(N) _____

(O) _____

(P) _____

(Q) _____

(R) _____

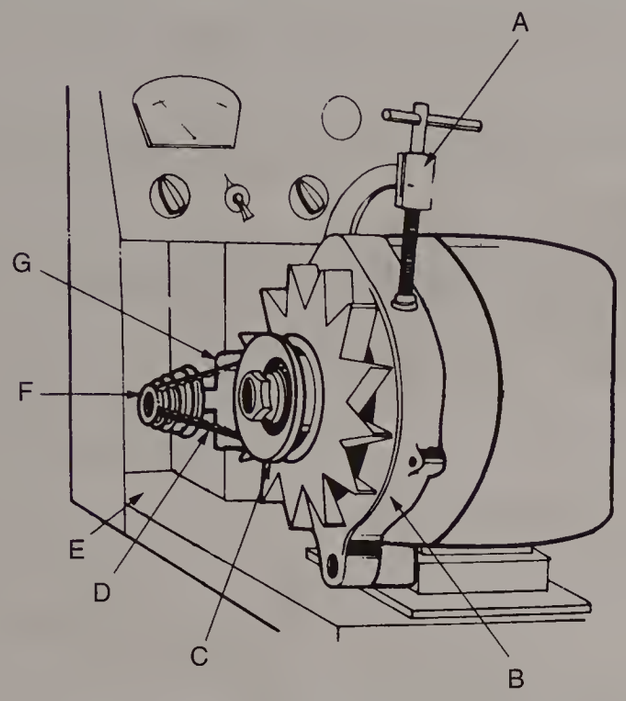
(S) _____

(T) _____

(U) _____

(V) _____

21. Identify the parts indicated on the diagram below.



(Florida Dept. of Voc. Ed.)

21. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____

Regulator Service

22. When a regulator fails:

(A) adjust it.

(B) replace it.

(C) repair it.

(D) Either (A) or (B).

22. _____

23. Turning a small _____ _____ on an electronic regulator will lower or raise the voltage setting of the regulator.

23. _____

24. If you ever work on a car with a point regulator, it is best to refer to an early _____ _____.

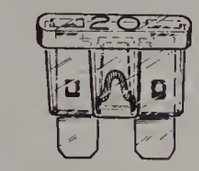
24. _____

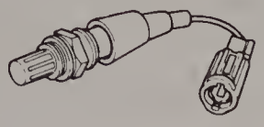
Name _____

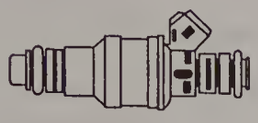
Date _____

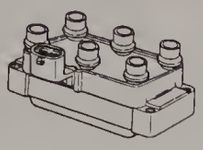
Instructor _____

Score _____ Text pages 437–464









Chapter 25
Ignition System Diagnosis and Repair

After studying this chapter and completing supplemental exercises, you will be able to:

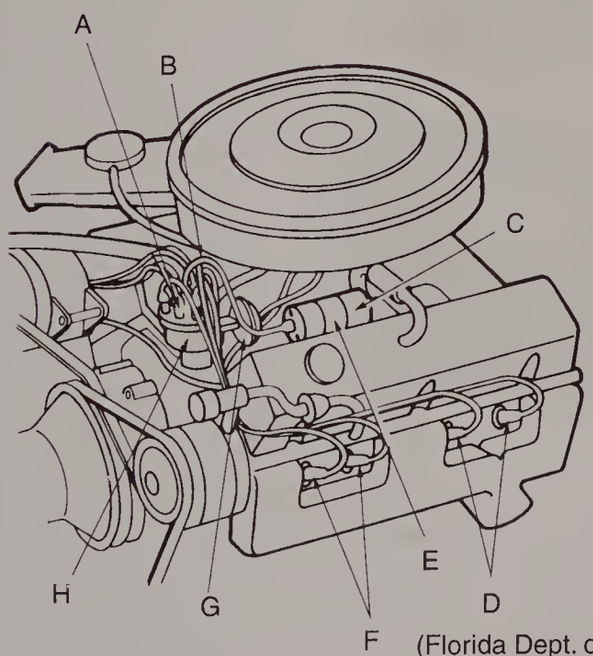
- Troubleshoot problems in an ignition system.
- Describe the symptoms that are produced by typical part failures.
- Summarize tests used to pinpoint ignition system troubles.
- Gap and replace spark plugs.
- Adjust contact point and pickup coil air gaps.
- Adjust ignition timing, when possible.
- Service a distributor.
- Analyze problems in a computer-controlled or distributorless ignition system.

Instructions: As you study Chapter 25 of the text, complete the following workbook problems in the spaces provided.

Troubleshooting Ignition Problems

1. Identify some basic troubles that can be found in an ignition system.

1. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____



(Florida Dept. of Voc. Ed.)

2. Name the ignition system circuits and components in which a scan tool can detect troubles.

_____

_____

_____

_____

_____

_____

_____

3. When an engine cranks or turns with the starting motor, but will not start and run, you should check for spark and _____. 3. _____

4. Unlike older ignition systems, some late-model ignition systems can produce enough _____ to cause serious electrical shock. 4. _____

5. The brightness and length of the electric arc (spark) produced by the ignition system can be measured by a(n) _____ _____ test. 5. _____

6. It is possible to have a good _____ when there are still problems in the ignition system. 6. _____

7. A(n) _____ _____ is a cylinder that is not burning fuel on the power stroke. 7. _____

8. Name the four types of test equipment contained in an engine analyzer.

_____

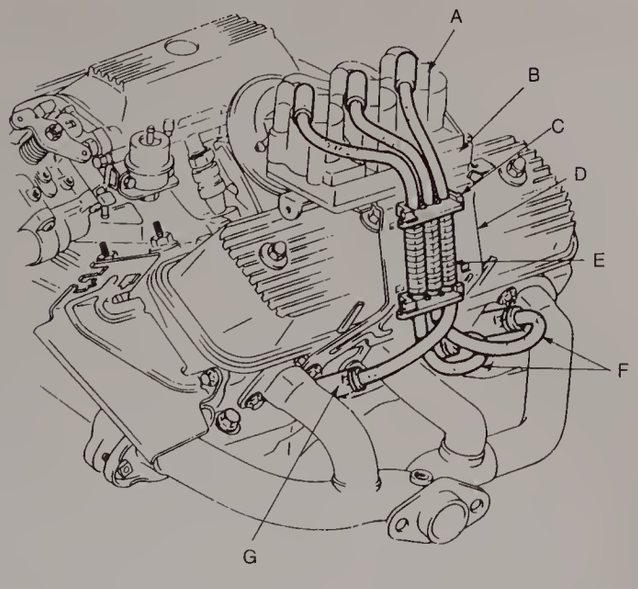
_____

_____

_____

Spark Plug and Coil Wire Service

9. Identify the types of trouble to look for when inspecting secondary wires. 9. (A) _____



(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

Name _____

10. A(n) _____ _____ _____ (secondary wire insulation, secondary wire resistance) test is used to check the condition of a spark plug or coil wire conductor. 10. _____

11. A bad spark plug wire will often have almost infinite _____. 11. _____

12. A(n) _____ _____ _____ test is used to check for sparks arcing through the insulation to ground. 12. _____

13. A condition where electric arcs pass through the wire insulation is spark plug _____ _____. 13. _____

Servicing Spark Plugs

14. Use a(n) _____ to test spark plugs. 14. _____

15. A spark plug should be removed by: 15. _____

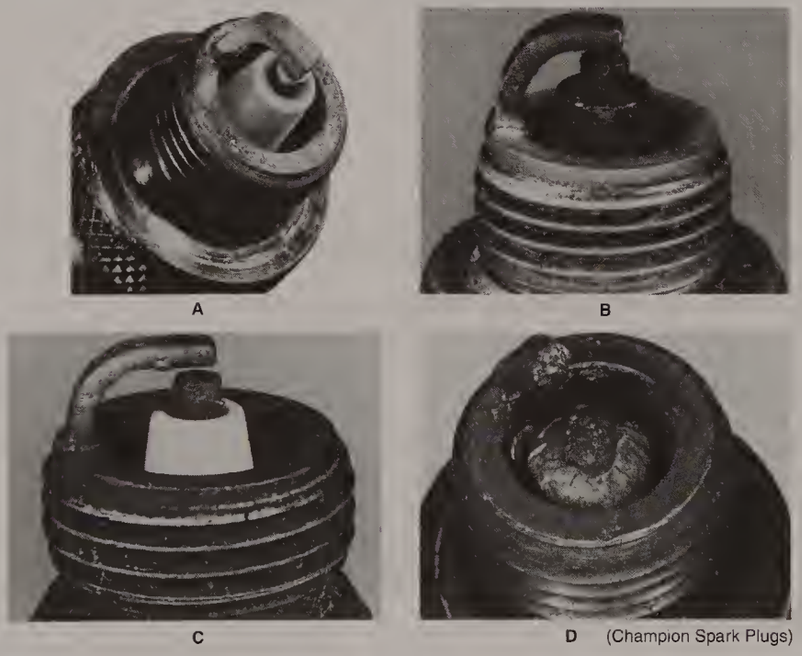
    (A) pulling on the wire.

    (B) grasping and pulling on the boot.

    (C) Either (A) or (B).

    (D) None of the above.

16. Indicate and detail the condition of each of the spark plugs below.



A B C D (Champion Spark Plugs)

(A) _____

_____

(B) _____

_____

(C) _____

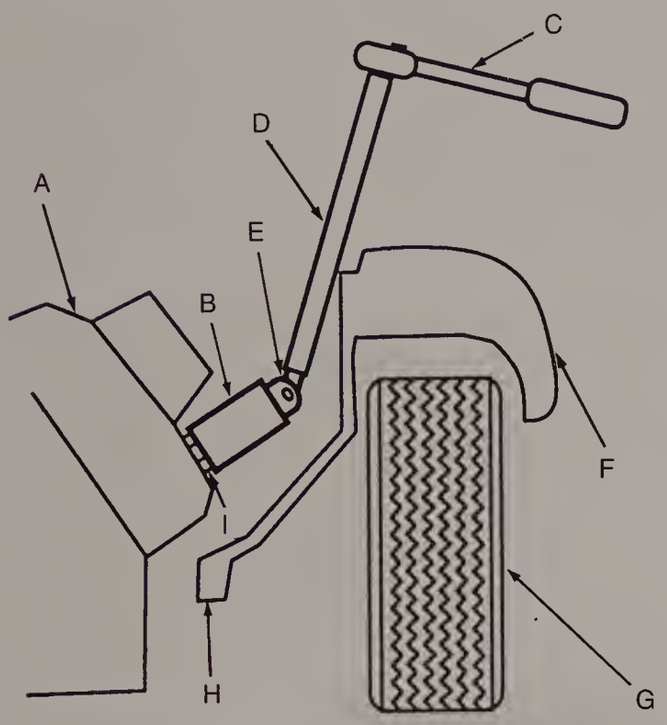
_____

(D) _____

_____

17. Spark plug _____ vary from approximately .030 in. (0.76 mm) on contact point ignitions to over .080 in. (2.03 mm) on electronic systems. 17. _____

18. Identify the items indicated in the diagram below.



18. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____

Distributor Service

19. A carbon trace can: 19. _____

(A) cause the spark plugs to fire out of sequence or not at all.

(B) short coil voltage to ground or to a wrong terminal lug in the distributor cap.

(C) cause the spark plugs to fire poorly.

(D) All of the above.

20. If a distributor cap is not installed correctly, _____ and distributor damage can result. 20. _____

Electronic Distributor Service

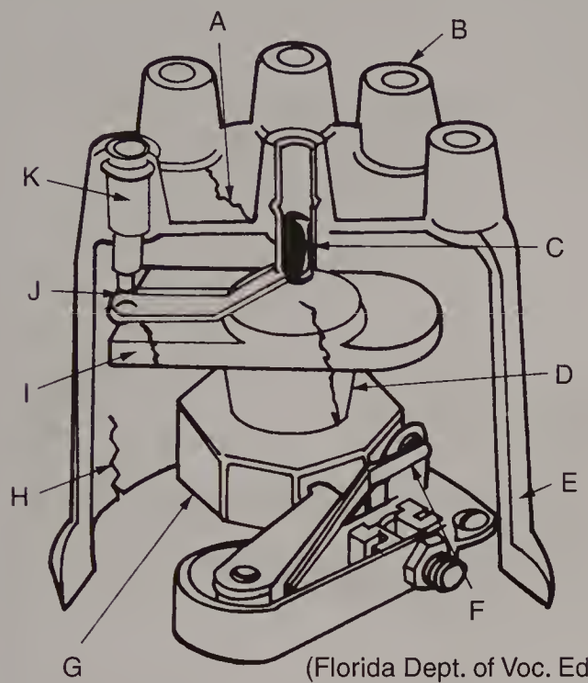
21. Most electronic type distributors use a(n) _____ _____ to sense trigger wheel rotation and engine speed. 21. _____

22. To compare actual pickup coil resistance with specs, use a(n) _____ _____ _____ test. 22. _____

23. The pickup coil air gap is the space between the pickup coil and a(n) _____ _____ tooth. 23. _____

Name _____

24. Identify the types of problems that can develop in an older contact point distributor as indicated on the diagram below.



(Florida Dept. of Voc. Ed.)

24. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____

25. If a condenser is shorted: 25. _____

(A) the engine will not start.

(B) burning will result.

(C) arcing will result.

(D) None of the above.

26. If distributor points are burned and pitted, or if the block is worn, the points must be: 26. _____

(A) repaired.

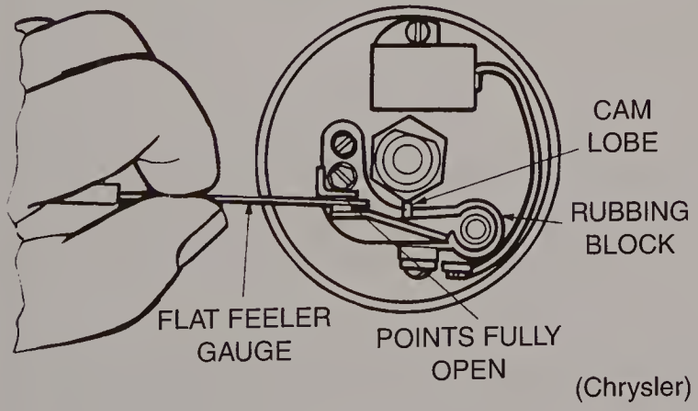
(B) replaced.

(C) left alone.

(D) None of the above.

27. Any continuous reading on the ohmmeter other than _____ means that the condenser is leaking and must be replaced. 27. _____

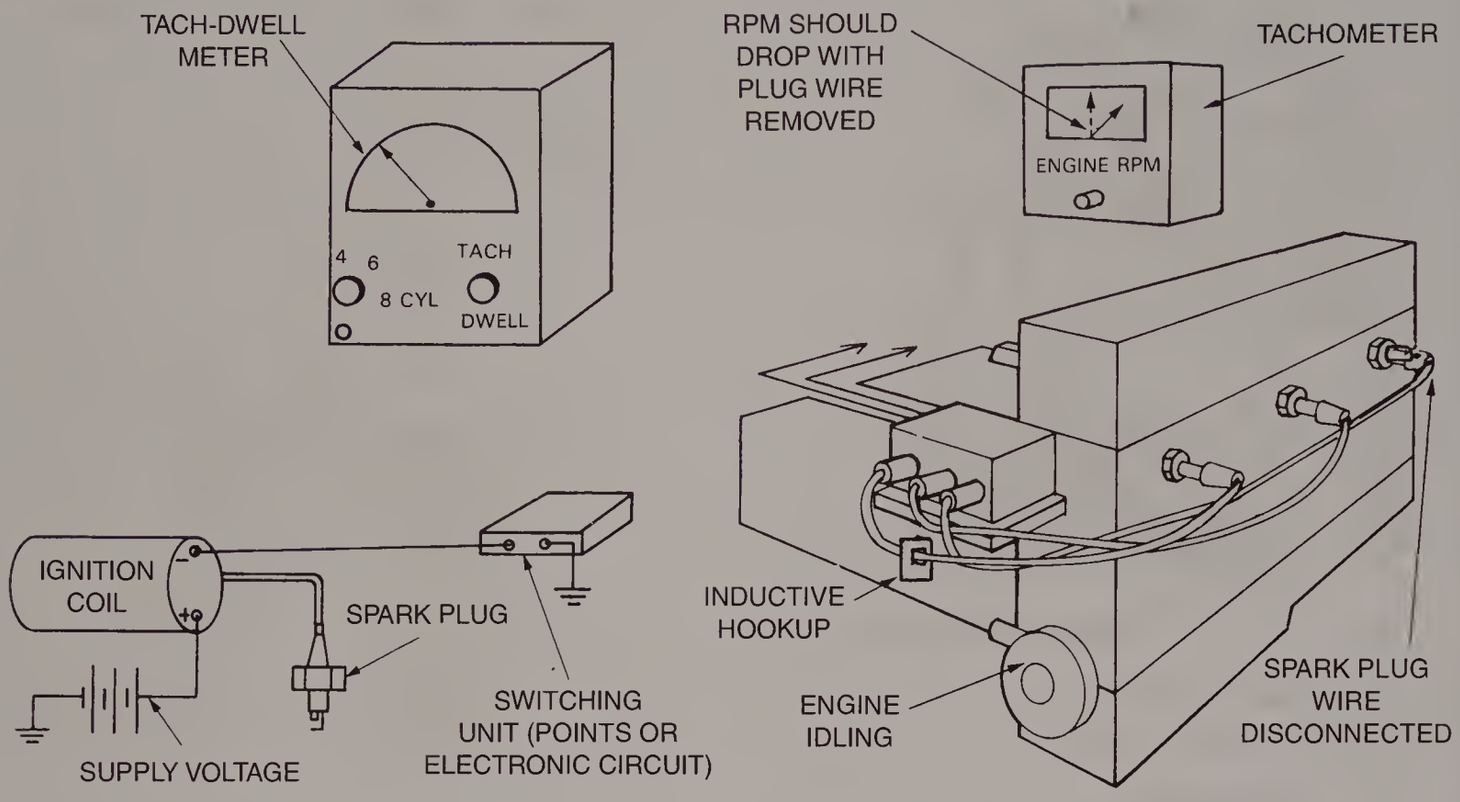
28. What is happening in the illustration below?



(Chrysler)

_____
_____
_____
_____
_____
_____

29. Draw in the wires connecting the tach-dwell meter to the diagrams of the ignition systems below.



A
Older Ignition System

B
Distributorless Ignition System

30. The points should always be adjusted _____ (after, before) the ignition timing. 30. _____

Cylinder Balance Test

31. In the chart below, identify the problems causing the various cylinder balance test results.

CYLINDER BALANCE TEST RESULTS	SCOPE KV	PROBLEMS
1. One or more cylinders dead (no RPM drop)	High (above 5 kV)	
2. One or more cylinders dead (no RPM drop)	Low (below 5 kV)	
3. One or more cylinders low	Low	
4. One or more cylinders low	High	
5. Two adjacent cylinders dead or low	Low	
6. Four cylinders low. (All four cylinders use the same intake manifold passageway)	High	

Name _____

Ignition Timing Adjustment

32. When ignition timing is too _____ , the engine may suffer from spark knock or ping. 32. _____

33. In most late-model vehicles, if timing is not correct, the ECM or another component must be: 33. _____

(A) adjusted.

(B) repaired.

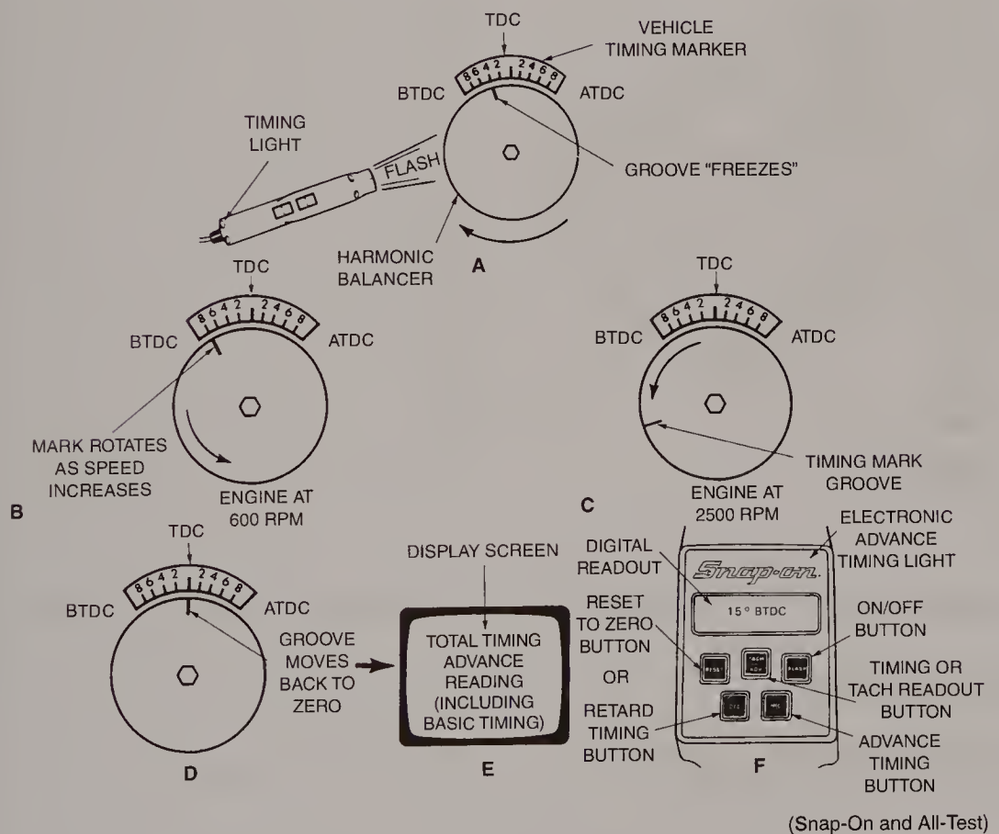
(C) replaced.

(D) eliminated.

34. A(n) _____ _____ is used to measure ignition timing. 34. _____

Distributor Advance Service

35. Describe what is happening in each of the diagrams below. 35. (A) _____



(Snap-On and All-Test)

(B) _____

(C) _____

(D) _____

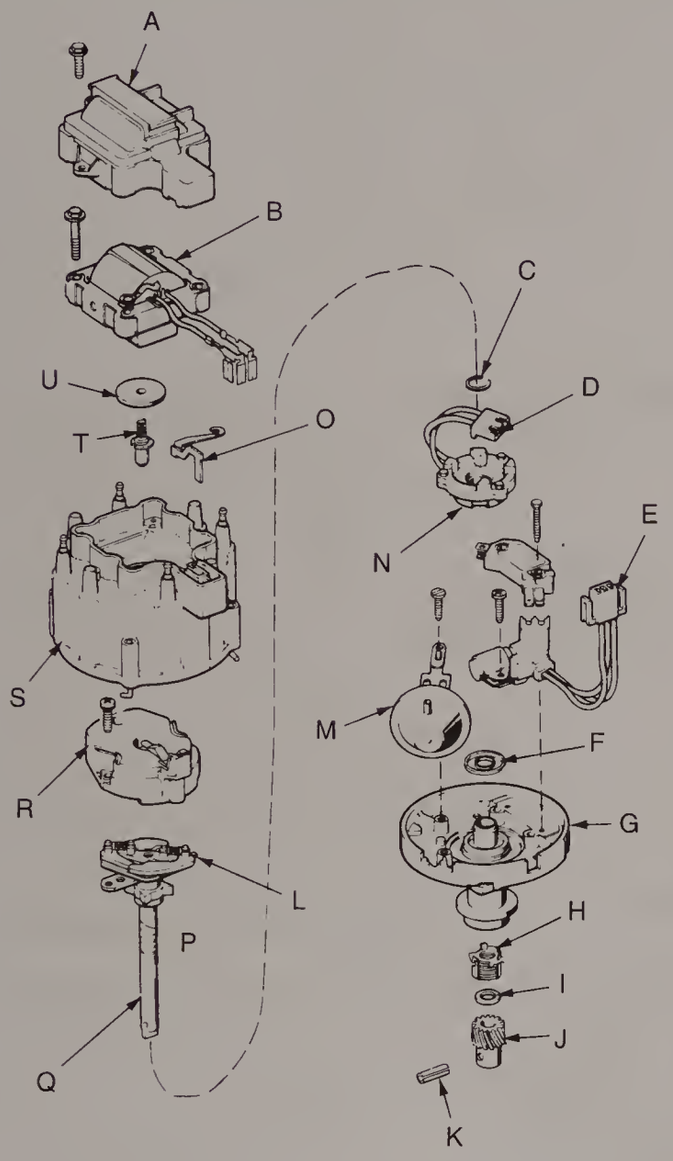
(E) _____

(F) _____

36. When a vacuum advance is used, use a vacuum pump to activate the diaphragm while measuring _____ change. 36. _____

37. When adjusting ignition timing, the distributor hold down _____ must be loosened to allow distributor rotation. 37. _____

38. Identify the parts indicated on the diagram of the distributor below. 38. (A) _____



(General Motors)

(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____
(R) _____
(S) _____
(T) _____
(U) _____

Ignition Resistance Circuit Testing

39. A(n) _____ _____ test may be needed when the voltage to the ignition coil in the RUN position is below or above specs. 39. _____

Ignition Coil Service

40. When testing an ignition coil, resistance of primary windings should be approximately one _____. 40. _____

41. A(n) _____ _____ is an easy way to check the action of an ignition switch. 41. _____

Name _____

Ignition Supply Voltage Test

42. Name components where an ignition supply voltage test will help locate troubles.

_____

_____

_____

_____

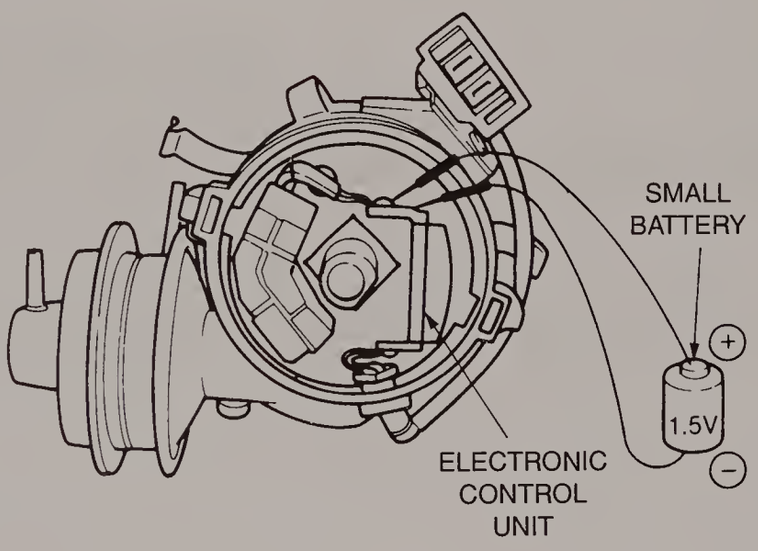
Ignition Control Unit Service

43. Explain why, quite often, an ignition control unit problem will show up after a period of engine operation.

_____

_____

_____



44. Describe what is happening in the diagram below.

_____

_____

_____

_____

45. When heating an ignition control unit to test it, heat the electronic control unit to a temperature: 45. _____

(A) equal to its normal operating temperature.

(B) higher than its normal operating temperature.

(C) lower than its normal operating temperature.

(D) the unit should never be heated.

Computerized Ignition System Service

46. A computerized ignition system can be seriously damaged if the wrong wire is shorted to ground or if a(n) _____ is connected improperly. 46. _____

Direct Ignition System Service

47. What is the main difference in the procedures for servicing a direct ignition system versus other types of ignition systems?

_____

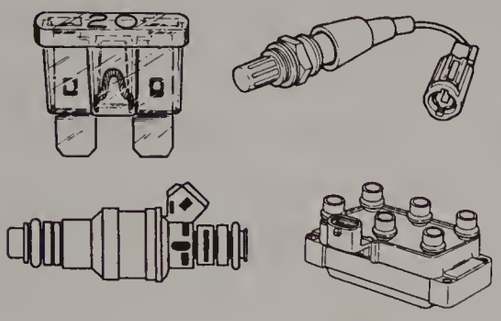
_____

Name _____

Date _____

Instructor _____

Score _____ Text pages 465–480



Chapter 26

Fuel and Emission Control Systems Electronics Service

After studying this chapter and completing supplemental exercises, you will be able to:

- Test electrical/electronic components found on late-model fuel and emission control systems.
- Use a fuel system wiring diagram.
- Explain new OBD II monitoring features used on late-model fuel injection and emission control systems.
- Describe the IM 240 emissions testing program.
- Cite safety rules that should be followed when testing fuel and emission control systems.

Instructions: As you study Chapter 26 of the text, complete the following workbook problems in the spaces provided.

Fuel System Electronics Service

1. Today's fuel injection systems are primarily controlled _____. 1. _____

2. Why should you never disconnect an EFI harness terminal when the ignition switch is in the *on* position?

_____

3. List four electrical/electronic parts that could be at fault when diagnosing fuel system problems.

_____

_____

_____

_____

4. List four mechanical parts that could prevent normal operation when diagnosing fuel system problems.

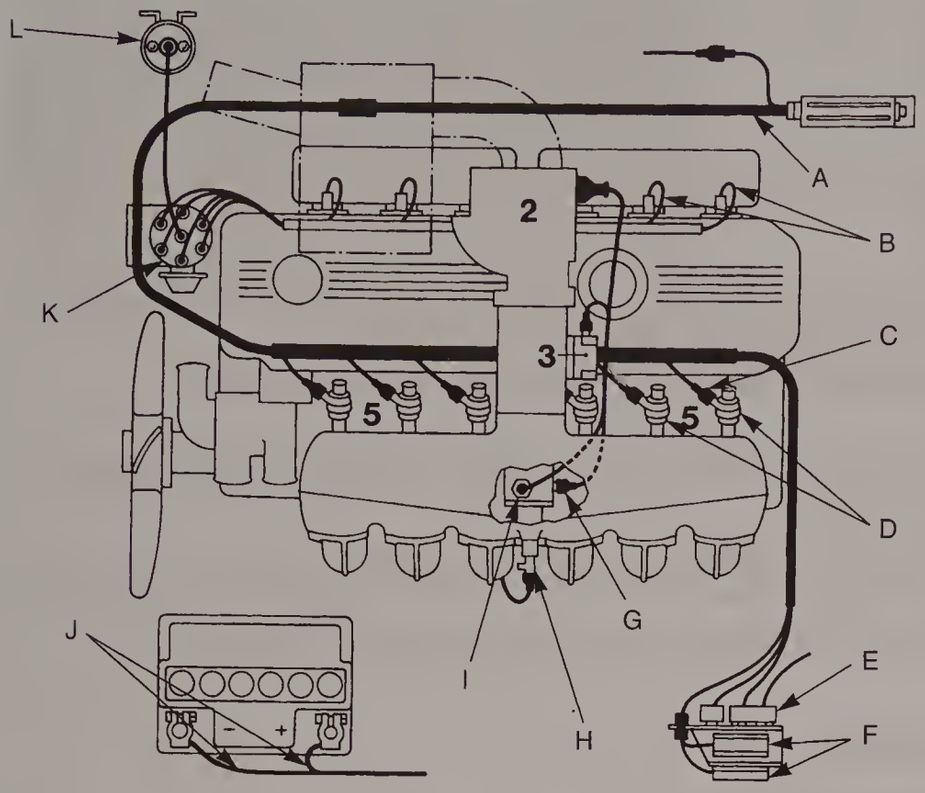
_____

_____

_____

_____

5. On the diagram below, identify the electrical connections that should be checked when diagnosing problems in EFI systems.



5. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

6. When the fuel system oxygen sensor detects abnormal combustion resulting from a poor fuel mixture, before it trips a trouble code, what happens?

_____

_____

_____

7. A(n) _____ _____ is a special test light that is used to check electronic fuel injector feed circuits. 7. _____

8. EFI testers: 8. _____

(A) can be used on a wide variety of vehicles.

(B) are usually vehicle specific and only designed to test one make of vehicle.

(C) are generic.

(D) None of the above.

Injector Problems

9. A bad injector can cause: 9. _____

(A) rough idle and engine miss.

(B) hard starting.

(C) poor fuel economy.

(D) All of the above.

Name _____

10. Describe the three injector problems listed below.

(A) *leaking injector:* _____

_____

(B) *dirty injector:* _____

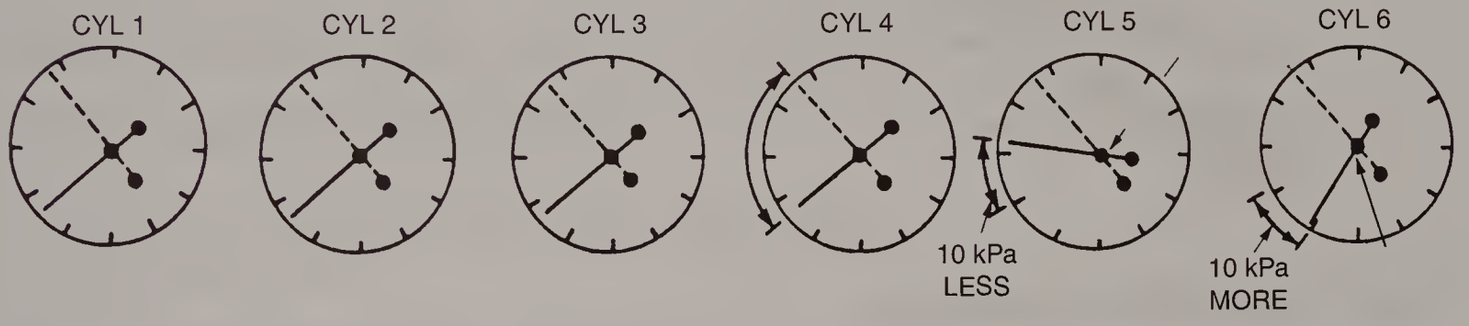
_____

(C) *inoperative injector:* _____

_____

Servicing EFI Multi-Point Injectors

11. Look at the diagrams below. Indicate whether each is a good injector, clogged injector, or a sticking/leaking injector.



A. _____ B. _____ C. _____ D. _____ E. _____ F. _____

Testing Idle Speed Control Motor

12. Describe how to check an idle speed motor.

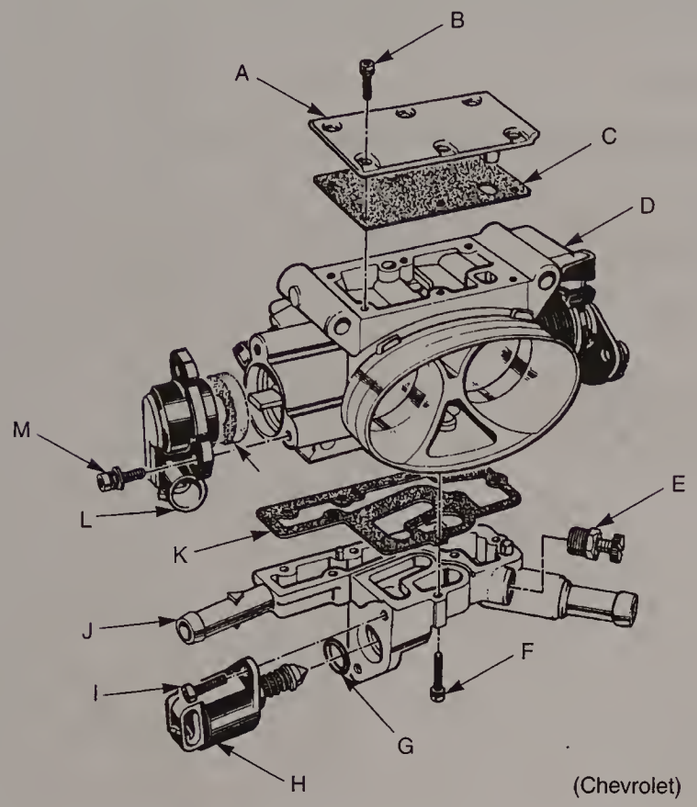
_____

_____

_____

13. A(n) _____ _____ _____ _____ tester will quickly determine if the motor is capable of altering engine idle speed. 13. _____

14. Identify the parts indicated on the throttle body below.



(Chevrolet)

14. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____

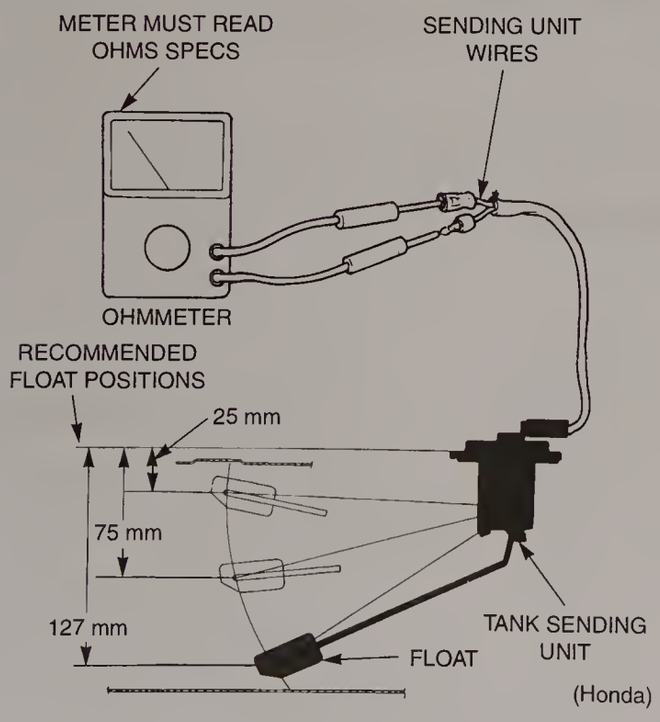
Fuel System Wiring Diagrams

15. When you have difficulty finding and connecting fuel system problems, refer to the _____ _____ _____ _____.

15. _____

Fuel Tank Sending Unit Service

16. What is being done in the diagram below?



(Honda)

_____
_____
_____
_____
_____
_____

Name _____

17. If there is a problem with an electronic fuel pump: 17. _____
    (A) ignore it since no repair is possible.
    (B) replace it immediately.
    (C) check the circuit and voltage supplied to pump.
    (D) None of the above.

Fuel Pump Shutoff Circuits

18. A(n) _____ _____ can be used to block current flow to the electrical fuel pump after a severe impact or collision. 18. _____

Emission Maintenance Reminder

19. The _____ _____ _____ is a circuit that automatically turns on a dash light to indicate the need for emission control system service. 19. _____

Emission Control System Electronics Service

20. _____ _____ systems monitoring checks components for leakage and restrictions that could increase emissions. 20. _____

21. _____ _____ system monitoring uses data from the rear O_2 sensor to determine if the right amount of air is being injected into the engine's exhaust stream. 21. _____

22. OBD II systems use at least two oxygen sensors. Where are they located?

_____

_____

23. _____ _____ _____ involves using a scan tool to check the condition of monitored parts of the various emission control systems. 23. _____

Inspecting Emission Control Systems

24. When inspecting emission control systems, what should you inspect?

_____

_____

_____

_____

Emission Testing Programs

25. The _____ _____ emissions test requires that the vehicle be operated on a dynamometer at speeds of up to 55 mph. (89 kmh) for 240 seconds while exhaust gas emissions are measured. 25. _____

26. The EPA estimates that approximately _____% of the vehicles tested will fail their emission tests. 26. _____

(A) 25

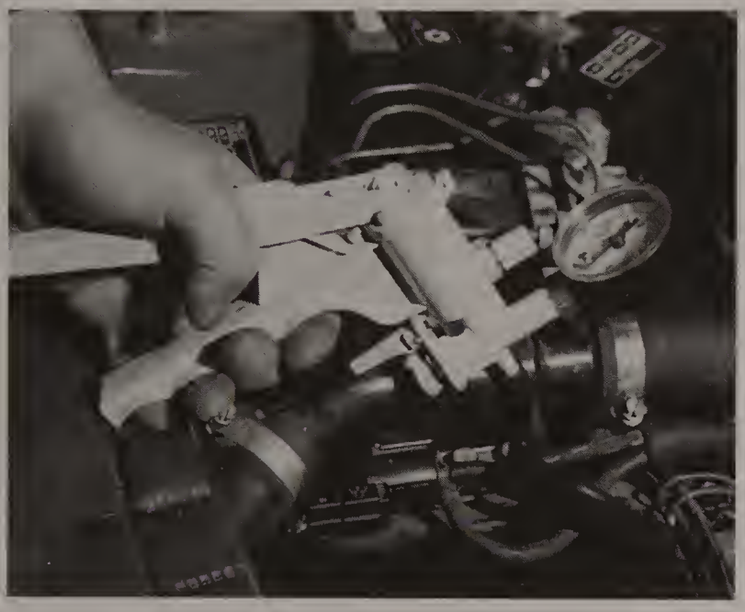
(B) 35

(C) 50

(D) 85

Vacuum Solenoid Service

27. What is being done in the photo below?



_____

_____

_____

_____

_____

_____

Evaporative Emissions Control System Service

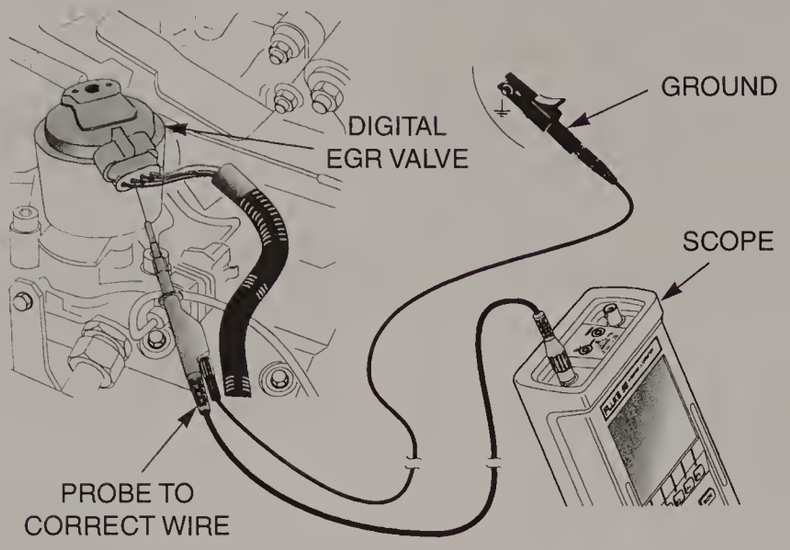
28. The evaporative emissions system _____ measures the flow of fuel vapors into the engine. 28. _____

29. An evaporative emissions system _____ test checks the system for leaks into the atmosphere. 29. _____

Name _____

EGR System Electronic Service

30. What is being done in the diagram below?



_____

_____

Oxygen Sensor Service

31. If a scanner shows a possible problem with an oxygen sensor, you might want to use a(n) _____ to check actual output. 31. _____

32. A(n) _____ _____ _____ _____ is a tool used to send a false 200 to 700 mV signal to the computer for testing purposes. 32. _____

Name _____

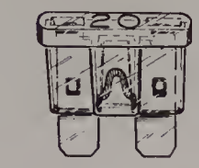
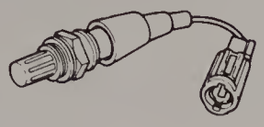
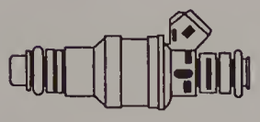
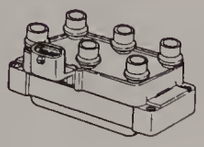
Date _____

Instructor _____

Score _____ Text pages 481–496

Chapter 27

Lighting System Diagnosis and Repair

After studying this chapter and completing supplemental exercises, you will be able to:

- Troubleshoot common lighting system problems.
- Perform basic tests on a lighting system.
- Remove and replace headlight and other bulbs.
- Aim headlights.
- Test and service light switches.
- Test and service lightbulb sockets.
- Test and replace flasher units.
- Replace a turn light switch.
- Test instrument and warning light sending units.
- Test gauges.
- Remove and replace a dash cluster.

Instructions: As you study Chapter 27 of the text, complete the following workbook problems in the spaces provided.

Lighting System Diagnosis

1. Normally, several _____ will not burn out all at once. 1. _____

2. If all the bulbs in a circuit are out: 2. _____

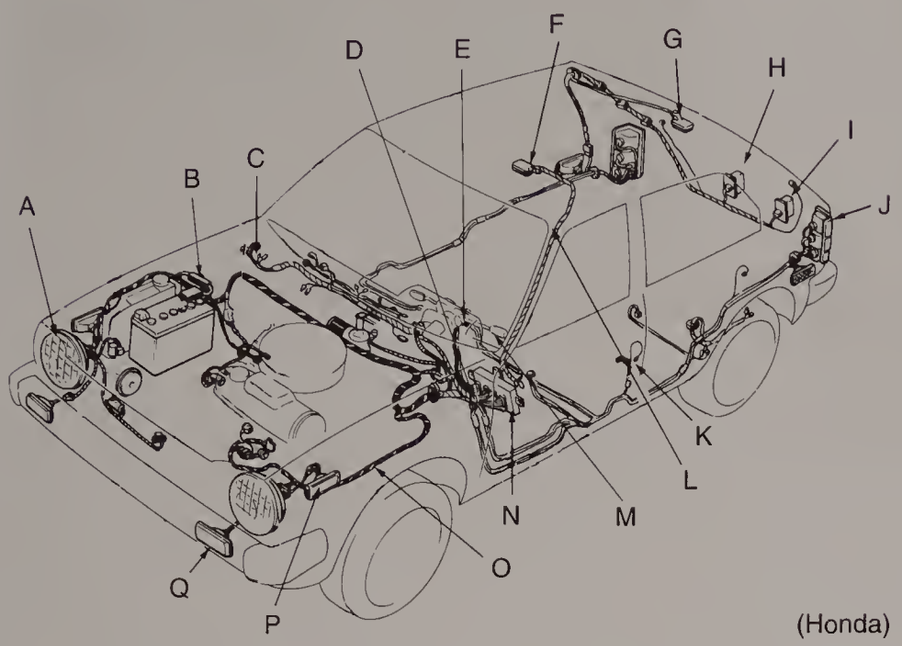
   (A) replace them.

   (B) you could have a bad circuit breaker or relay.

   (C) you could have a blown fuse.

   (D) Either (B) or (C).

3. Identify the types of problems that can occur in the lighting system of a car.



(Honda)

3. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____
(M) _____
(N) _____
(O) _____
(P) _____
(Q) _____

4. What might cause lights to flicker on and off?

_____

_____

5. The most common cause of high resistance and dim bulbs is a(n) _____ plug terminal or socket.

5. _____

Headlight Service

6. Sequentially list the basic steps for the replacement of a conventional sealed headlamp.

1. _____

_____

2. _____

_____

3. _____

_____

7. Explain why you should avoid touching a headlamp bulb with your fingers.

_____

_____

_____

_____

Name _____

8. Adjusting the bulbs so that they are pointing at a specified height and direction in front of the car is _____ _____. 8. _____

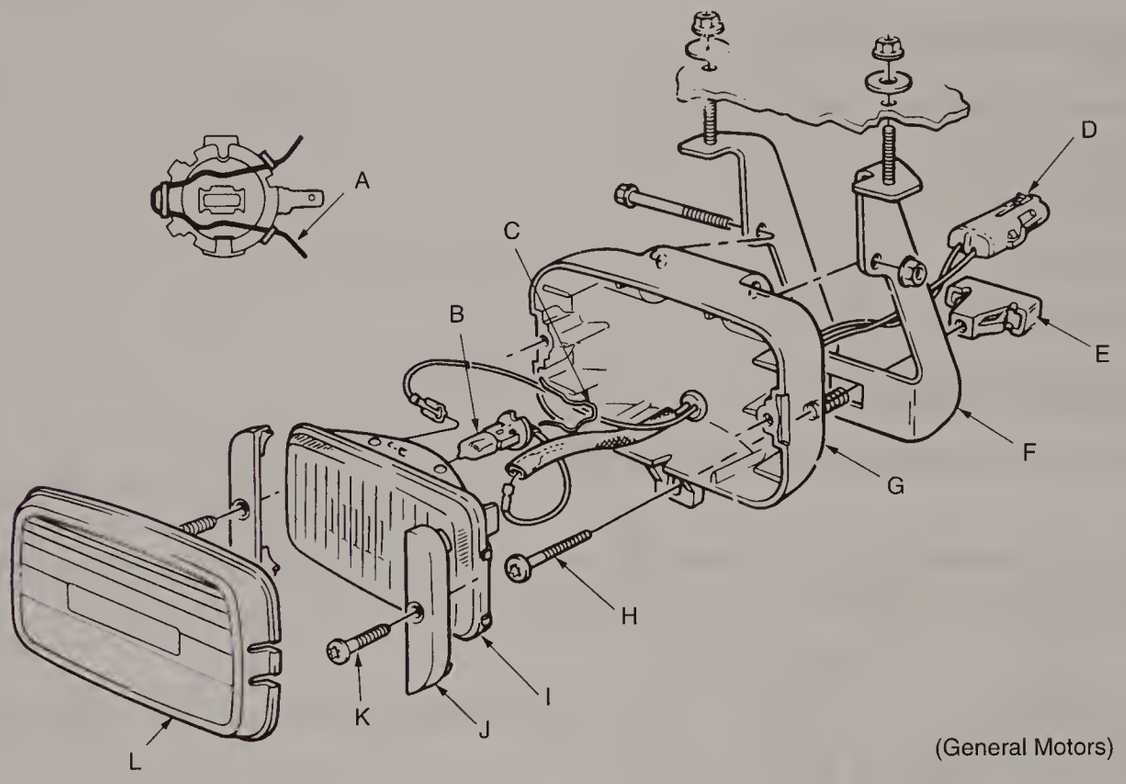
9. After turning the aiming _____ , recheck the reading on the headlamp aimers or how the lamps show on a marked wall. 9. _____

10. A bad _____ switch can be shorted or open on one or both sides. 10. _____

11. If both headlights are not working, the diagnosis may be a bad headlamp _____ which is shorted or open. 11. _____

Fog Lamp Service

12. Identify the parts indicated on the fog lamp circuit below.



(General Motors)

12. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____
(I) _____
(J) _____
(K) _____
(L) _____

Bulb Socket Service

13. The most common automotive bulb is the _____ that has two elements and staggered socket lugs. 13. _____

14. The _____ bulb is used for single purpose applications such as back-up lights. 14. _____

Flasher Service

15. A bad flasher _____ (will, will not) make a clicking sound. 15. _____

Turn Signal Switch Service

16. A combination switch that combines the turn signal switch with the headlamp, washer-wiper, and other switches, makes diagnosis: 16. _____

    (A) impossible.

    (B) more challenging.

    (C) very easy.

    (D) None of the above.

Brake Light Switch Service

17. Most brake light switches are mounted on the: 17. _____

    (A) steering column.

    (B) headlight switch.

    (C) brake pedal.

    (D) None of the above.

Instrumentation Service

18. Identify the parts indicated on the diagrams below.

18. (A) _____

(B) _____

(C) _____

(D) _____

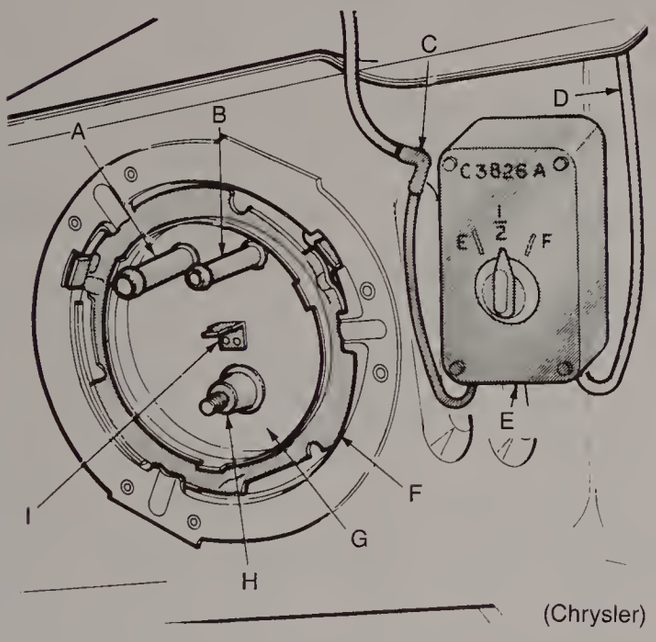
(E) _____

(F) _____

(G) _____

(H) _____

(I) _____



(Chrysler)

19. When replacing a digital dash cluster, many units have a removable _____ _____ _____ that electronically stores the mileage on the car. 19. _____

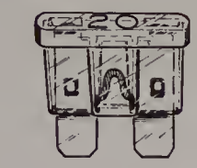
20. A faulty _____ _____ _____ causes gauges to loose the ability to show fluctuations in their readings with changes in charging system voltage, making them inoperative or inaccurate. 20. _____

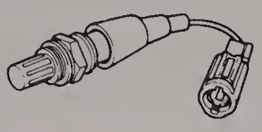
Name _____

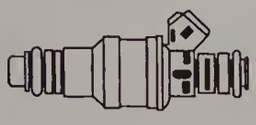
Date _____

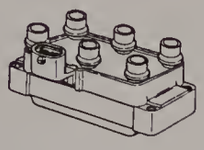
Instructor _____

Score _____ Text pages 497–516









Chapter 28

Testing and Repairing Other Systems

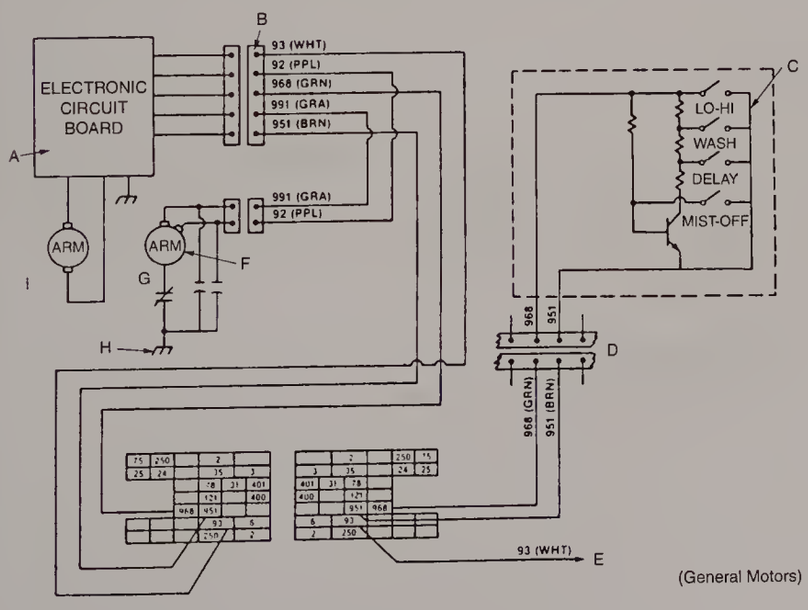
After studying this chapter and completing supplemental exercises, you will be able to:

- Diagnose and repair a wiper circuit.
- Service a windshield washer system.
- Repair inoperative horns.
- Diagnose and repair power windows.
- Service power door locks.
- Adjust a radio antenna trimmer screw.
- Replace a radio and its speakers.
- Use condensers to correct some types of radio noise.
- Remove and replace a door panel.
- Clean a tape player head.
- Describe basic tests for antilock brake systems.
- Service a rear window defogger circuit.
- Test and service a blower motor and its circuit.
- Describe speed control service.

Instructions: As you study Chapter 28 of the text, complete the following workbook problems in the spaces provided.

Wiper-Washer System Testing And Repair

1. Identify the types of problems that can be found in a wiper system.



(General Motors)

1. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

(I) _____

2. If you can hear the wiper motor running, but the wiper arms do not move, the cause may be:

   (A) a stripped gear.

   (B) a disconnected arm.

   (C) a bad switch.

   (D) Either (A) or (B).

2. _____

3. List five possible causes of an inoperative windshield washer.

_____

_____

_____

_____

_____

Horn Service

4. The horn is probably bad if the _____ _____ goes on and off.

4. _____

Power Window Service

5. On the diagram below, identify possible troubles for a typical power window circuit.

5. (A) _____

(B) _____

(C) _____

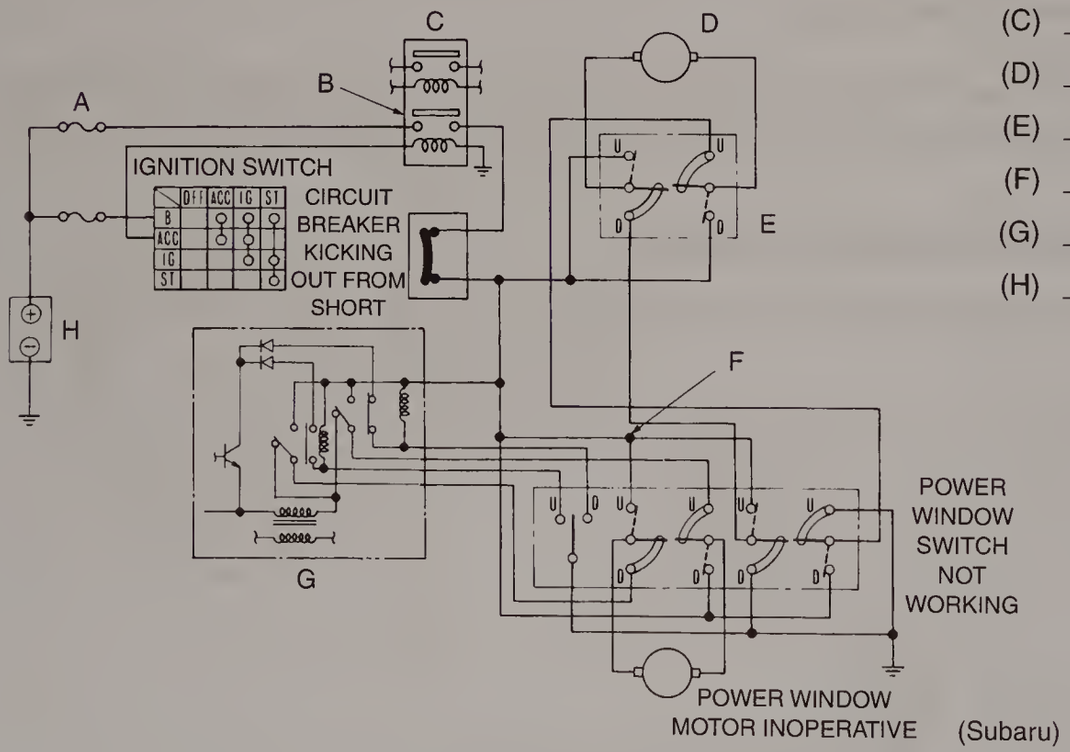
(D) _____

(E) _____

(F) _____

(G) _____

(H) _____

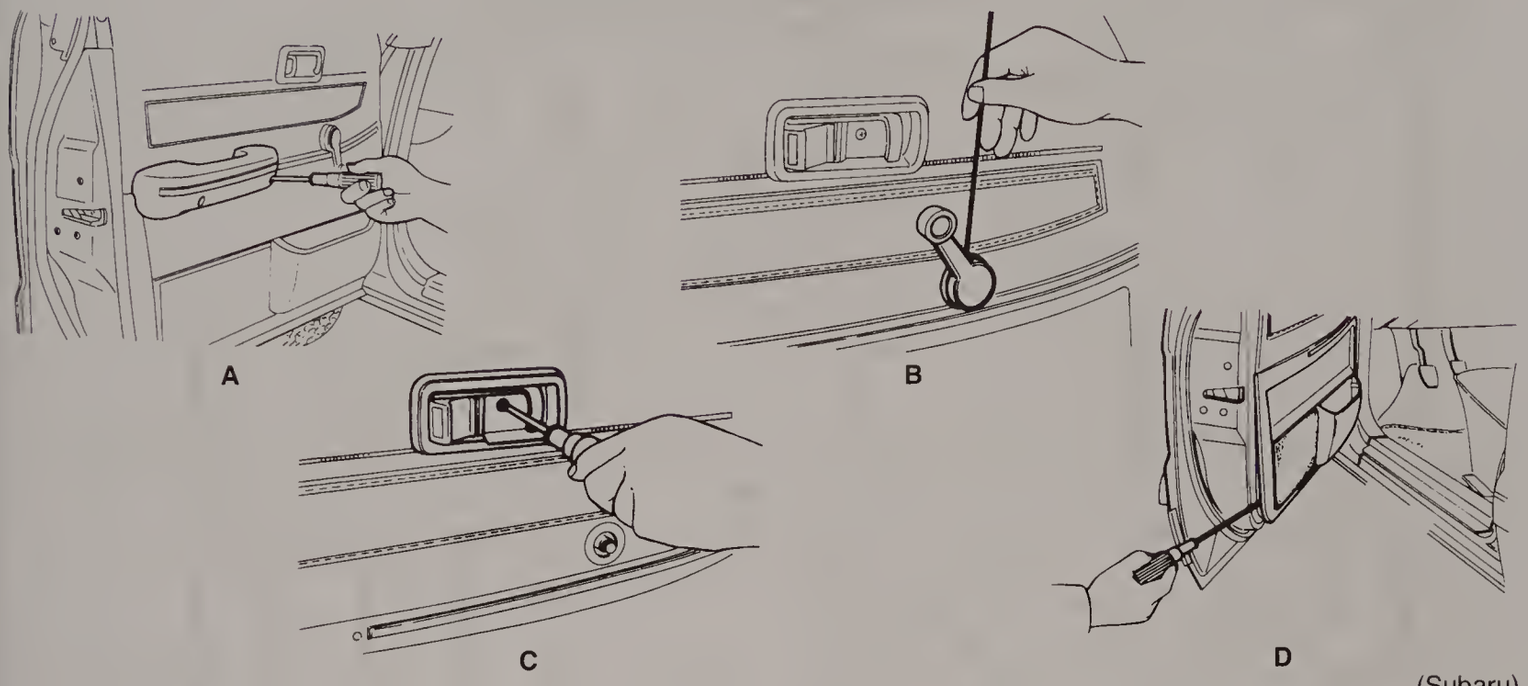


(Subaru)

Name _____

Power Door Lock Service

6. Describe the typical steps for door panel removal as illustrated below.



(Subaru)

(A) _____

_____

(B) _____

_____

(C) _____

_____

(D) _____

_____

Power Seat Service

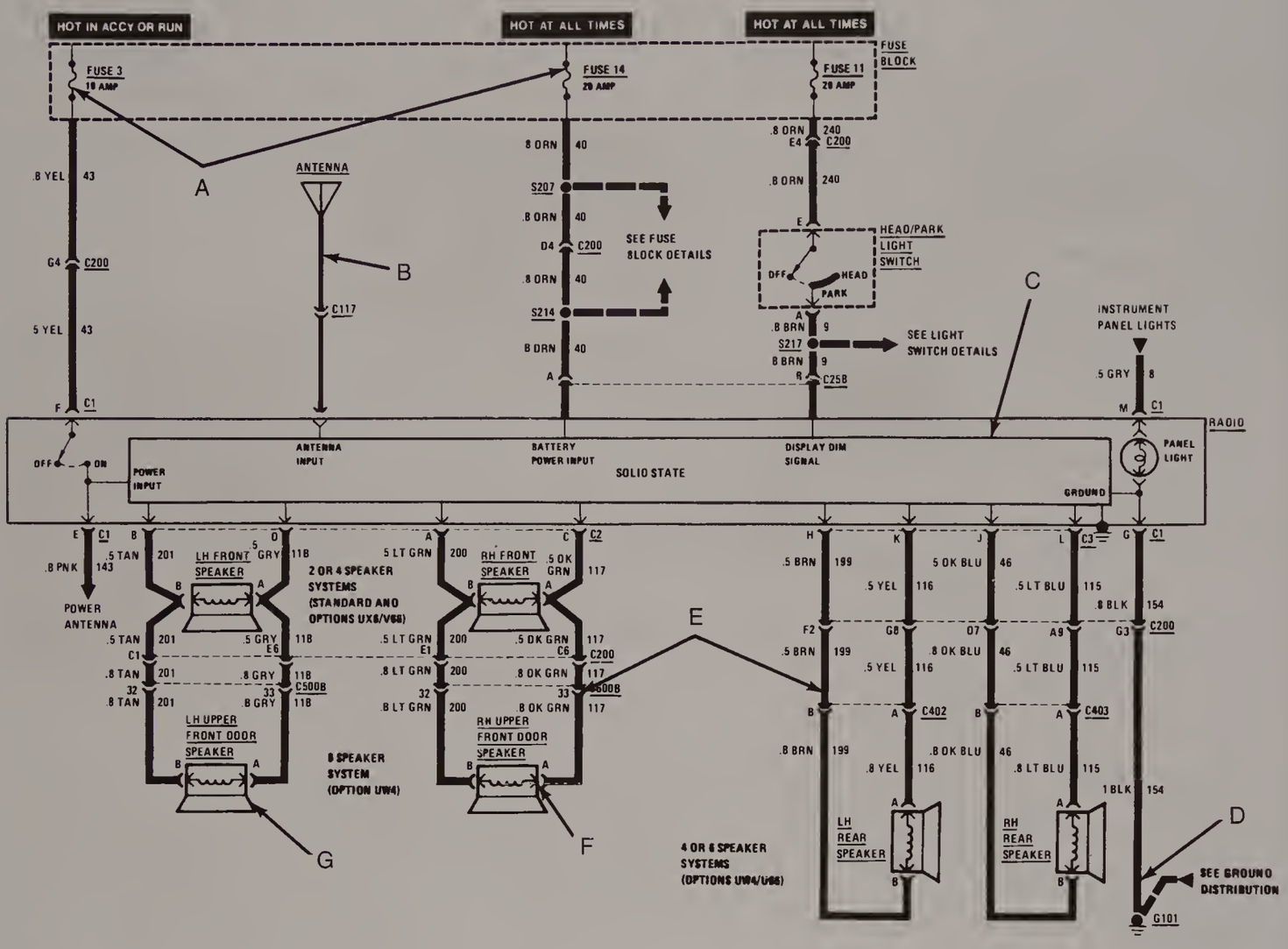
7. If any one of the seats is inoperative, what should you test?

_____

_____

Radio Service

8. Identify problems that could develop in a radio circuit.



(Oldsmobile)

8. (A) _____

(B) _____

(C) _____

(D) _____

(E) _____

(F) _____

(G) _____

9. Capacitors that absorb voltage fluctuation in the car's electrical system are known as _____ _____.

9. _____

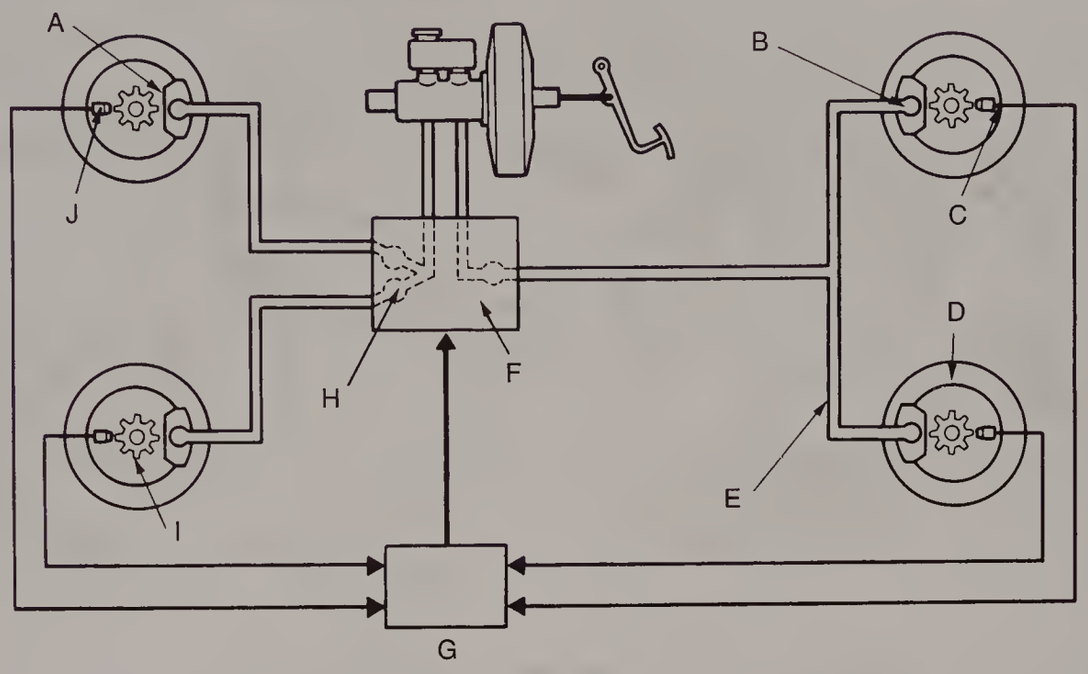
10. _____ are normally not repairable and should be replaced when defective.

10. _____

Name _____

Antilock Brake System Service

11. Identify problems that can develop in an antilock brake system.



11. (A) _____ (F) _____

(B) _____ (G) _____

(C) _____ (H) _____

(D) _____ (I) _____

(E) _____ (J) _____

12. A bad wheel speed sensor will normally be opened and will not produce _____ _____ signal for the computer. 12. _____

13. Explain why you should always release hydraulic pressure before working on an ABS hydraulic unit.

_____

_____

Rear Window Defogger Service

14. List four causes of an inoperative rear window defogger circuit.

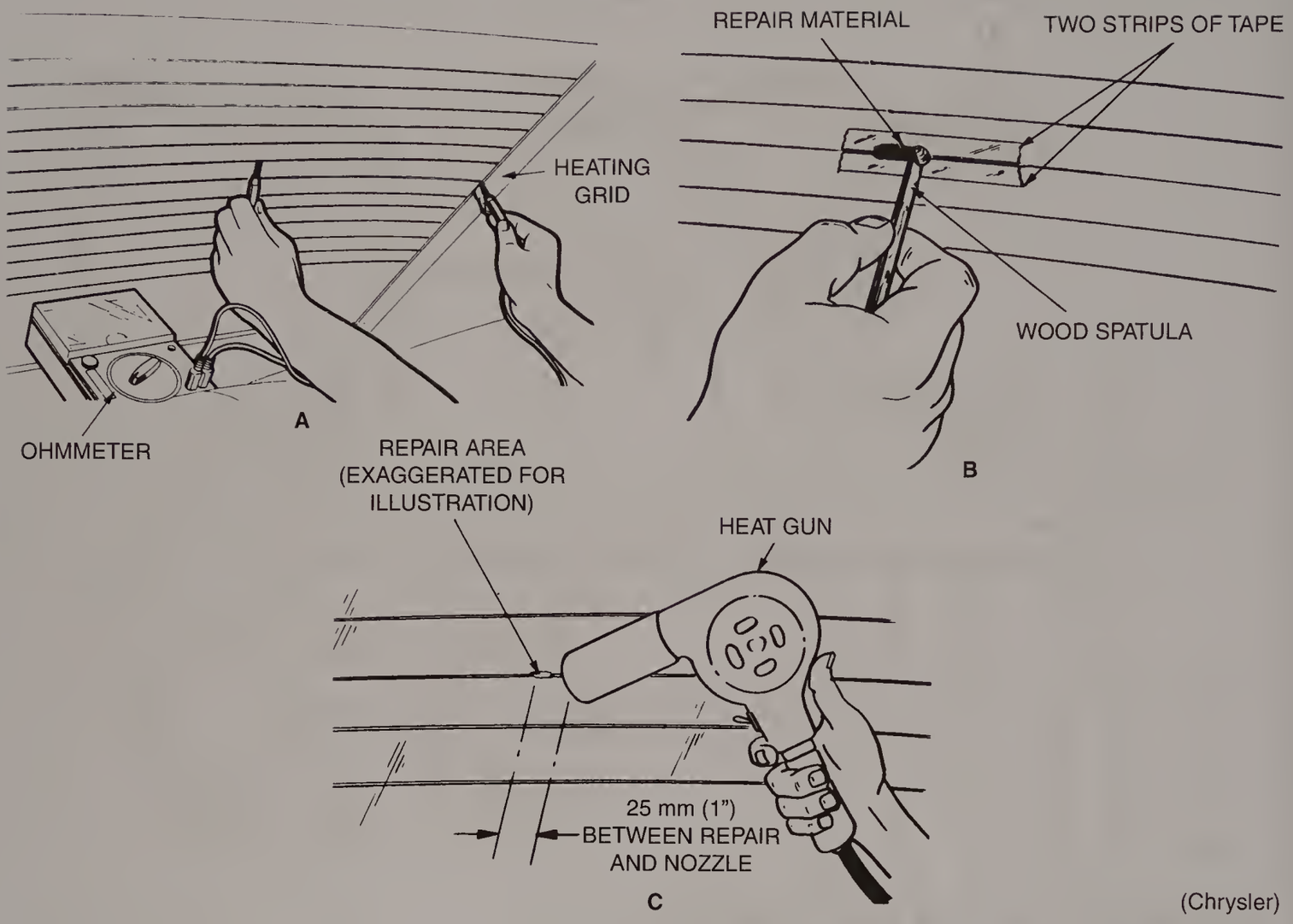
_____

_____

_____

_____

15. Describe what is happening in each of the diagrams below.



(Chrysler)

15. (A) _____

(B) _____

(C) _____

Heater, Air Conditioning Circuit Repairs

16. The _____ for the heater blower and air conditioning systems vary considerably from car to car. 16. _____

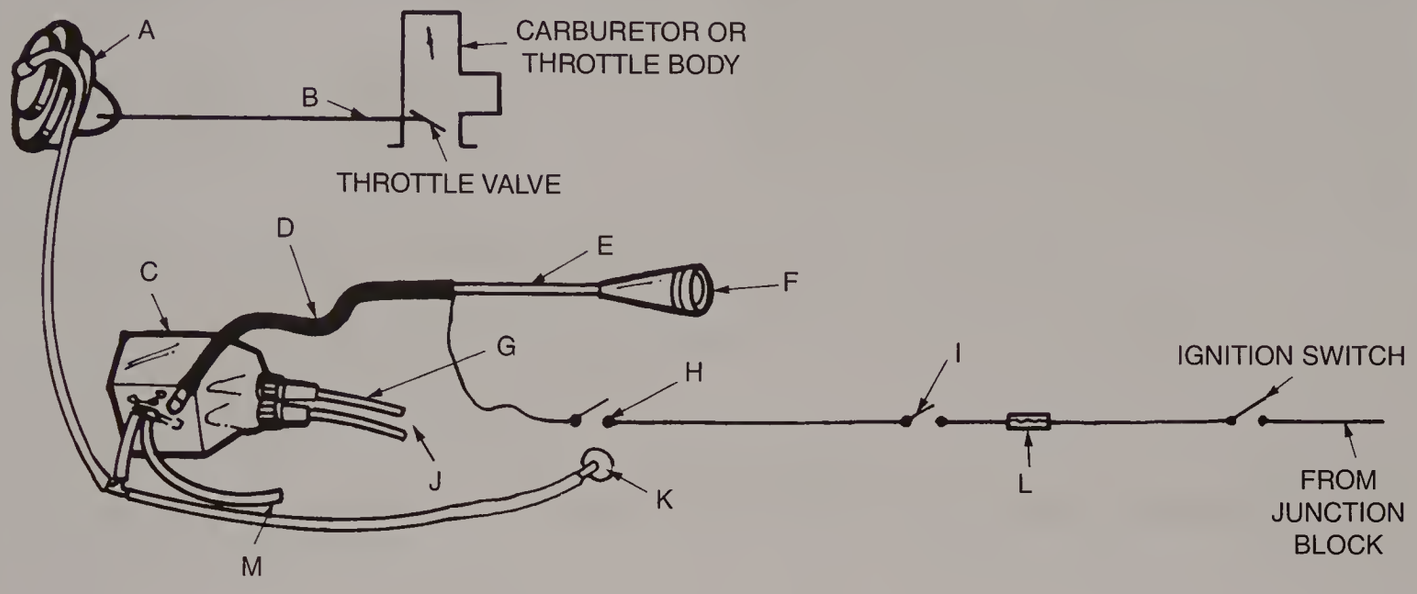
17. A bad blower resistor pack will prevent the fan or blower operation on one of the _____ (higher, slower) speed settings. 17. _____

18. In most cases, the blower motor must be replaced when _____ are noisy. 18. _____

Name _____

Speed Control System Service

19. Identify the types of problems that can develop in a speed control system.



19. (A) _____ (H) _____
(B) _____ (I) _____
(C) _____ (J) _____
(D) _____ (K) _____
(E) _____ (L) _____
(F) _____ (M) _____
(G) _____

Other System Service

20. Which of the following is one of the best sources of information when working on complex electrical-electronic circuits? 20. _____

(A) Trial and error.

(B) A classmate.

(C) A factory service manual.

(D) None of the above.

Name _____

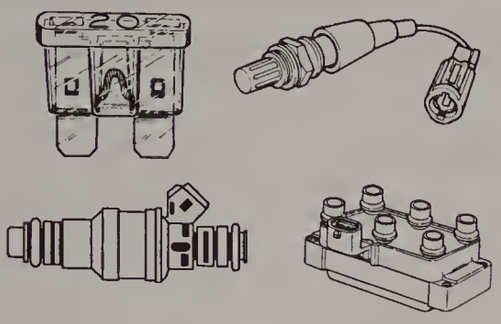
Date _____

Instructor _____

Score _____ Text pages 517–544

Chapter 29

Advanced Diagnostics, Analyzers



After studying this chapter and completing supplemental exercises, you will be able to:

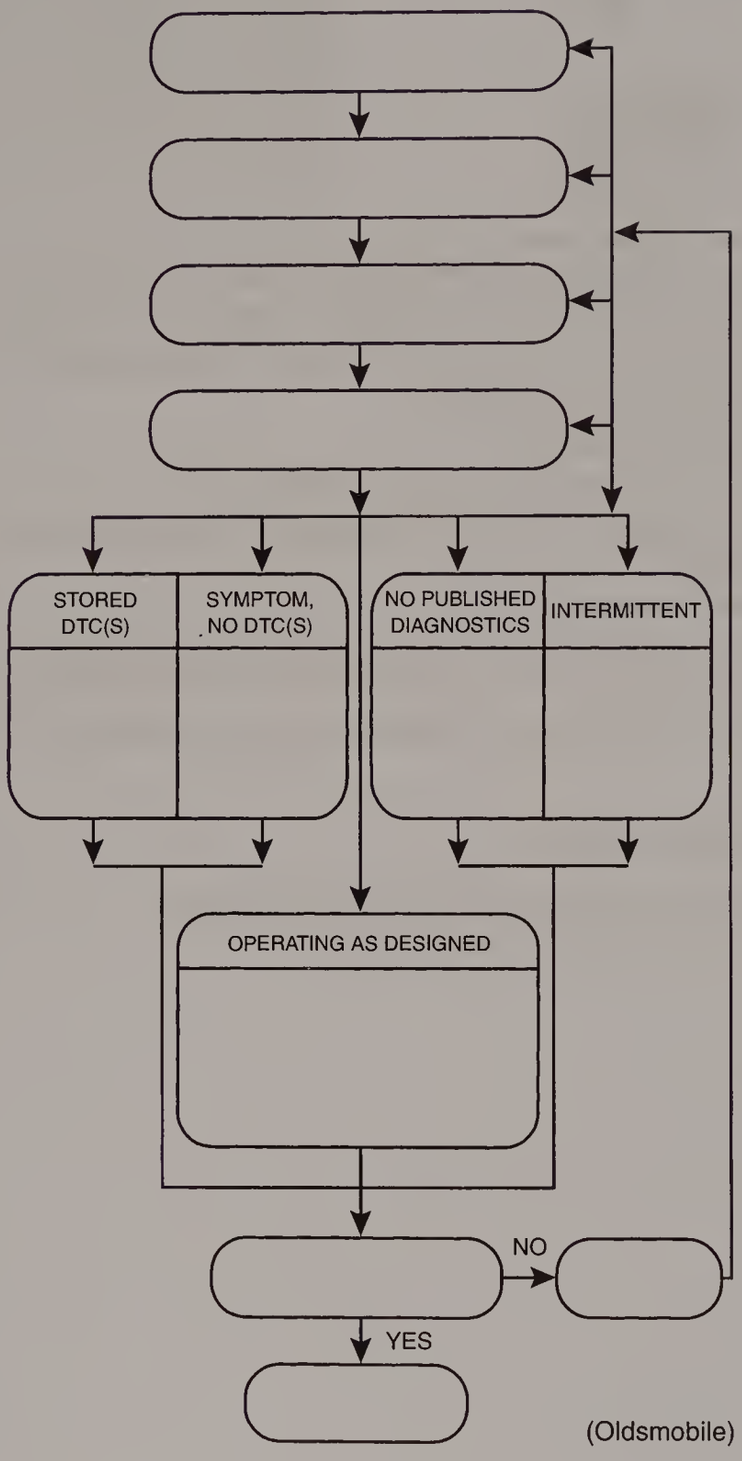
- Use advanced methods to troubleshoot problems caused by electrical-electronic devices.
- Use a scan tool to find problems not tripping trouble codes by using datastream values.
- Use a break-out box to measure circuit values.
- Explain the principles of an oscilloscope.
- Summarize how to use an engine analyzer and handheld scope.
- Summarize how to use waveforms to analyze the operation of sensors, actuators, ECU outputs, and other electrical-electronic devices.
- Evaluate ignition system waveforms.
- Use an exhaust gas analyzer to find problems caused by the computer system.

Instructions: As you study Chapter 29 the text, complete the following workbook problems in the spaces provided.

Strategy-Based Diagnostics

1. Using a consistent, logical procedure to narrow down the possible _____ _____ is involved in strategy-based diagnostics. 1. _____

2. Complete the following flow chart indicating the basic steps for strategy-based diagnostics.



(Oldsmobile)

Name _____

Advanced Diagnostics

3. In the chart below, indicate the service procedure that would be used.

	Variable factor	Influential part	Target condition	Service procedure
1	Mixture ratio	Pressure regulator	Made lean	
			Made rich	
2	Ignition timing	Crankshaft position sensor	Advanced	
			Retarded	
3	Mixture ratio feedback control	Oxygen sensor	Suspended	
		ECM	Operation check	
4	Idle speed	IAC valve-AAC valve	Raised	
			Lowered	
5	Electrical connection (Electric continuity)	Harness connectors and wires	Poor electrical connection or improper wiring	
6	Temperature	ECM	Cooled	
			Warmed	
7	Moisture	Electric parts	Damp	
8	Electric loads	Load switches	Loaded	
9	Closed throttle position switch condition	ECM	ON-OFF switching	
10	Ignition spark position	Timing light	Spark power check	

(Nissan)

4. An instantaneous reading of operating parameters is a scan tool _____ - _____. 4. _____

5. Scan tool _____ values are "live" electrical values measured with the vehicle running or driving, almost eliminating the need for a breakout box or pinpoint measurements of electrical values. 5. _____

6. When performing the OBD II drive cycle, the typical cycle will take _____ minutes to complete, depending on the manufacturer. 6. _____

   (A) 2 to 3

   (B) 8 to 15

   (C) 20 to 40

   (D) 53 to 60

7. Explain why you should never connect a low-impedance (resistance) analog meter or test light to a computer system unless instructed to do so by the service manual.

_____

_____

_____

8. A(n) _____ _____ is one of the last tools used in diagnostics, as it is time-consuming. 8. _____

9. List three sources of electromagnetic interference (EMI).

_____

_____

_____

10. List six systems or components that a digital pyrometer can be used to detect.

_____

_____

_____

_____

_____

_____

11. A(n) _____ is used to measure an engine's power output and performance. 11. _____

Engine Analyzer (Computer Analyzer)

12. List six items that most engine analyzers check.

_____

_____

_____

_____

_____

_____

13. Some analyzers use a(n) _____ , an electronic device that allows computer data or signals to be sent or received over telephone lines. 13. _____

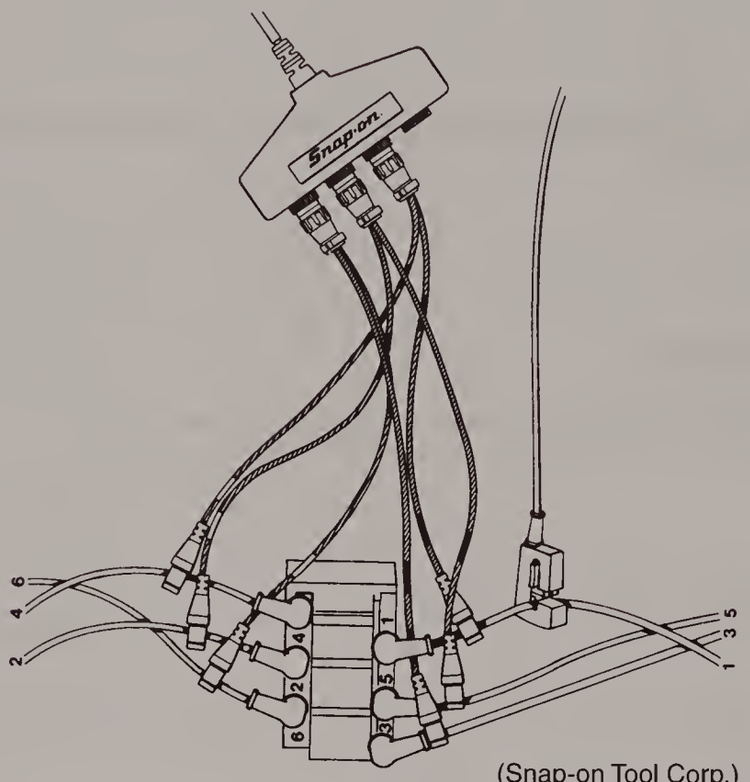
Name _____

Analyzer Connections

14. What is being illustrated in the diagram below?

_____

_____



(Snap-on Tool Corp.)

Using an Analyzer

15. The maximum available voltage produced by the ignition coil is measured by a scope _____ _____ _____ test. 15. _____

16. A test that measures the spark plug firing voltages when engine speed is rapidly increased is a(n) _____ test. 16. _____

17. During a cylinder balance test, if the rpm drop in one or more cylinders is below normal, describe the type of problem that could be indicated.

_____

_____

_____

18. A(n) _____ _____ test is done to check the engine's mechanical condition. 18. _____

(A) magnetic sensor

(B) cylinder balance

(C) cranking balance

(D) flight record

Oscilloscope

19. When using an oscilloscope, by comparing the scope pattern (line shape) to a known good pattern, what can the technician determine?

_____

_____

Ignition System Patterns

20. Identify the items indicated on the typical primary scope pattern below. 20. (A) _____

(B) _____

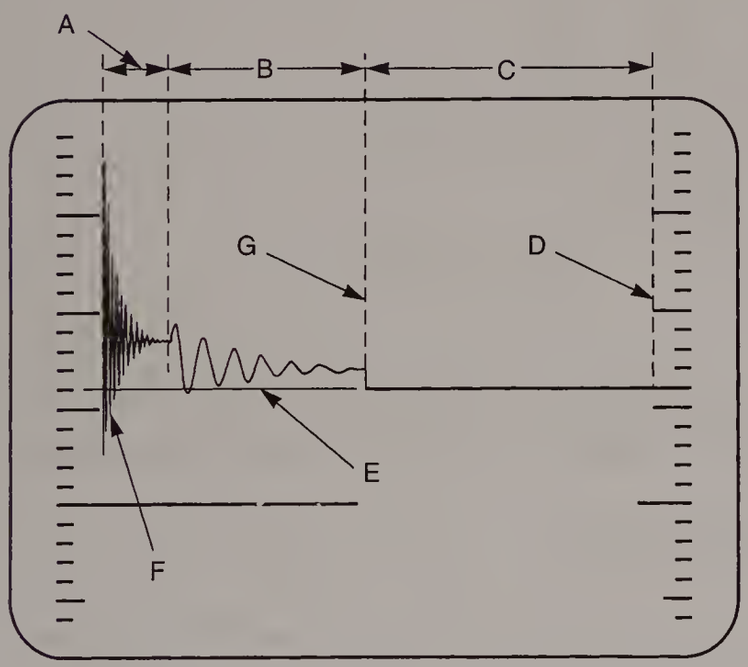
(C) _____

(D) _____

(E) _____

(F) _____

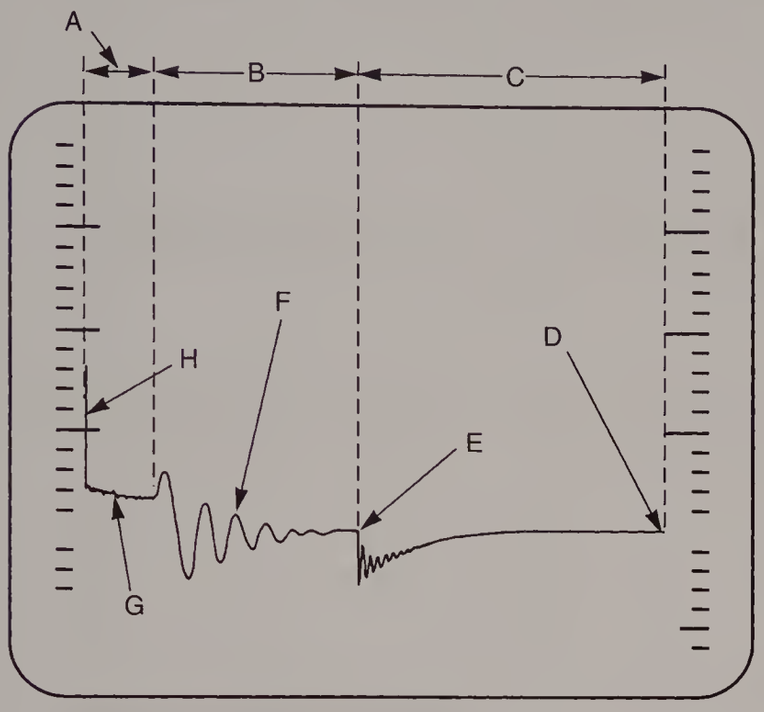
(G) _____



(FMC)

Name _____

21. Identify the items indicated on the typical secondary scope pattern below.



(FMC)

21. (A) _____
(B) _____
(C) _____
(D) _____
(E) _____
(F) _____
(G) _____
(H) _____

Scope Test Patterns

22. List the five scope test patterns commonly used by the technician when checking ignition system operation.

_____

_____

_____

_____

_____

Reading Oscilloscope Patterns

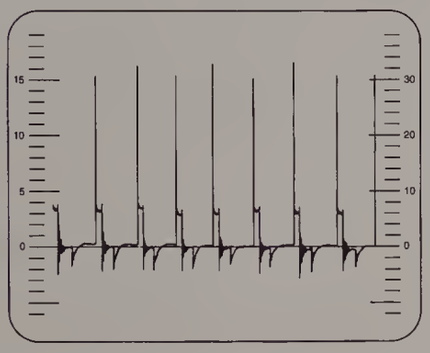
23. Explain how to read a scope pattern.

_____

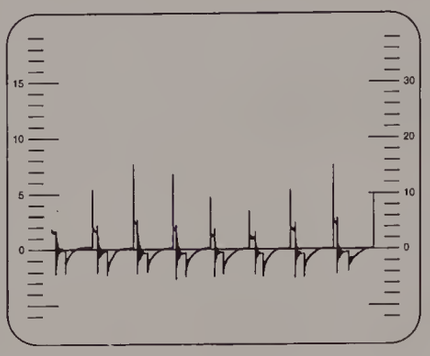
_____

_____

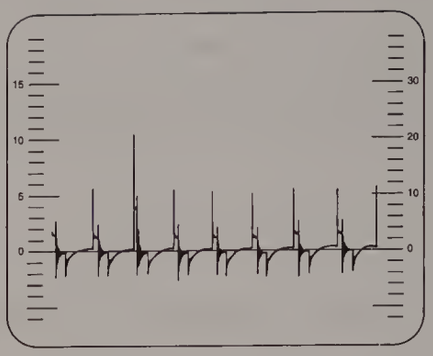
24. Look at each of the examples of bad scope patterns below. Identify the problem and describe the cause of each.



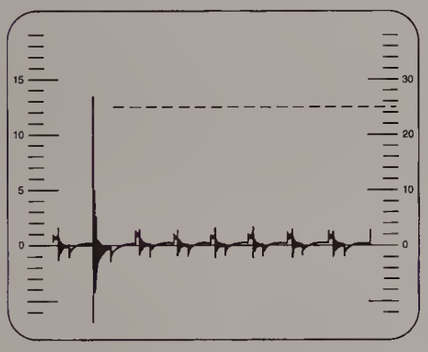
(A) _____



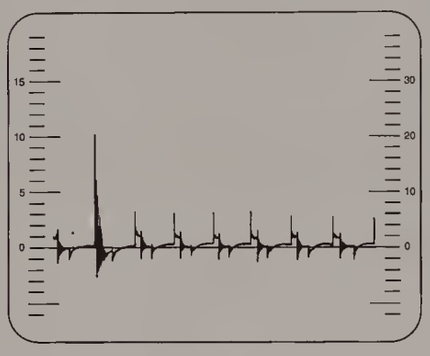
(B) _____



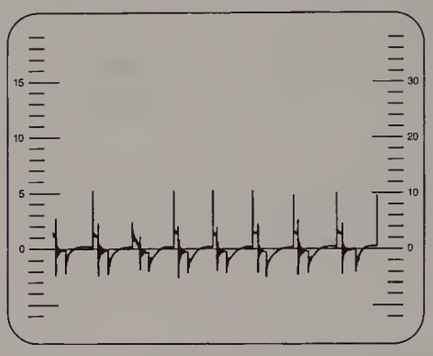
(C) _____



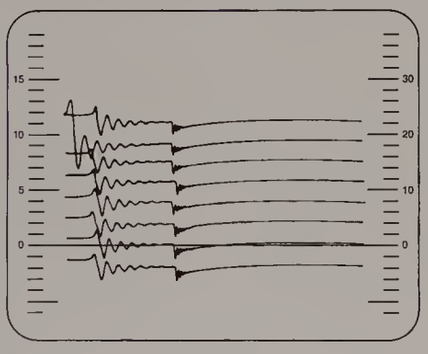
(D) _____



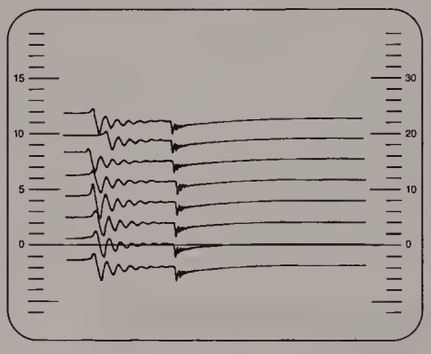
(E) _____



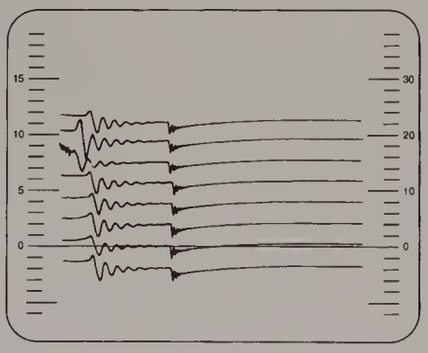
(F) _____



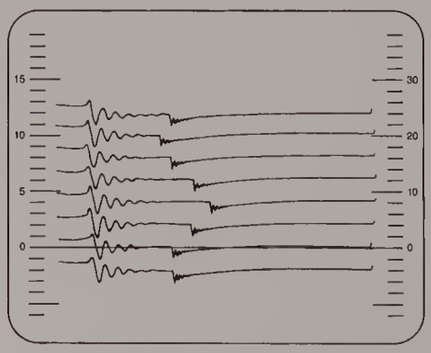
(G) _____



(H) _____



(I) _____



(J) _____

(FMC)

Name _____

Computer System Scope Tests

25. List six things you should check when analyzing a square wave.

_____

_____

_____

_____

_____

_____

26. List four things you should check when analyzing sine waves.

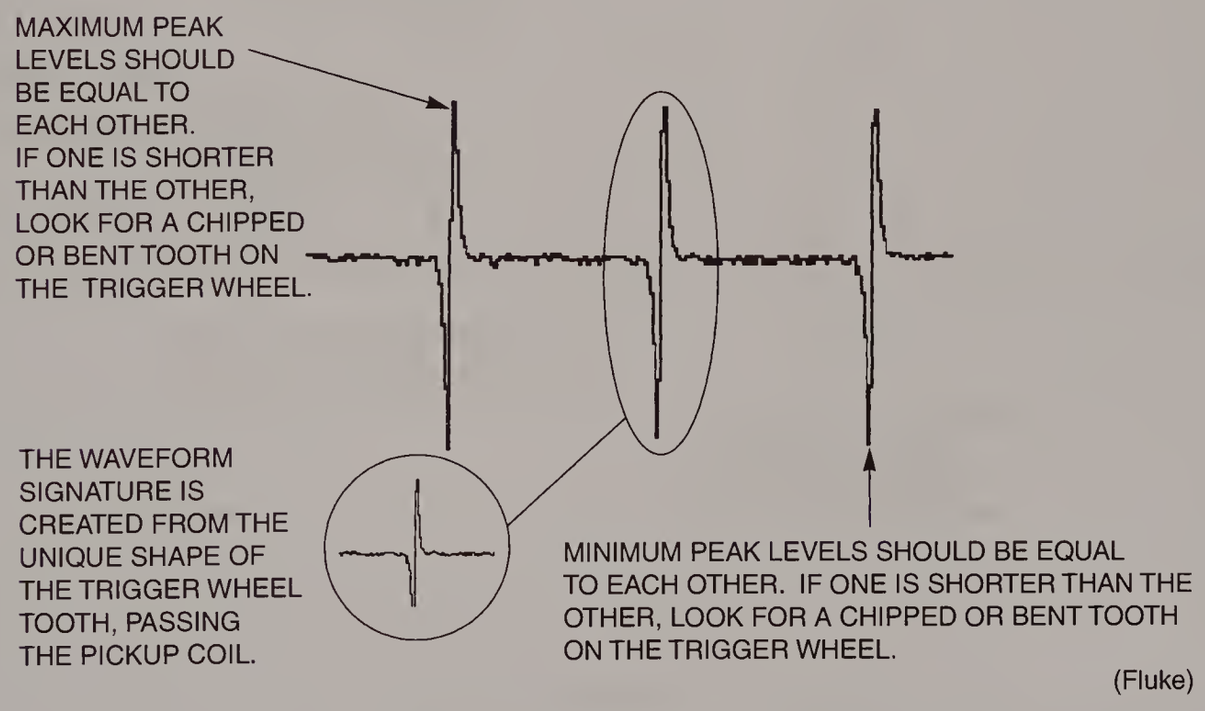
_____

_____

_____

_____

27. Identify the diagram shown below.

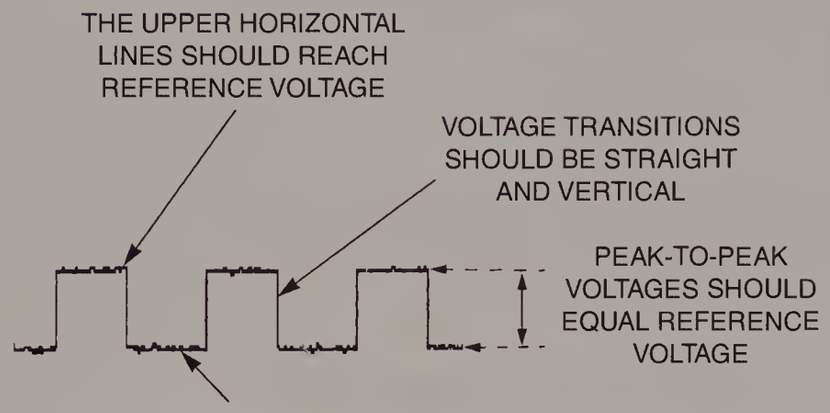


(Fluke)

_____

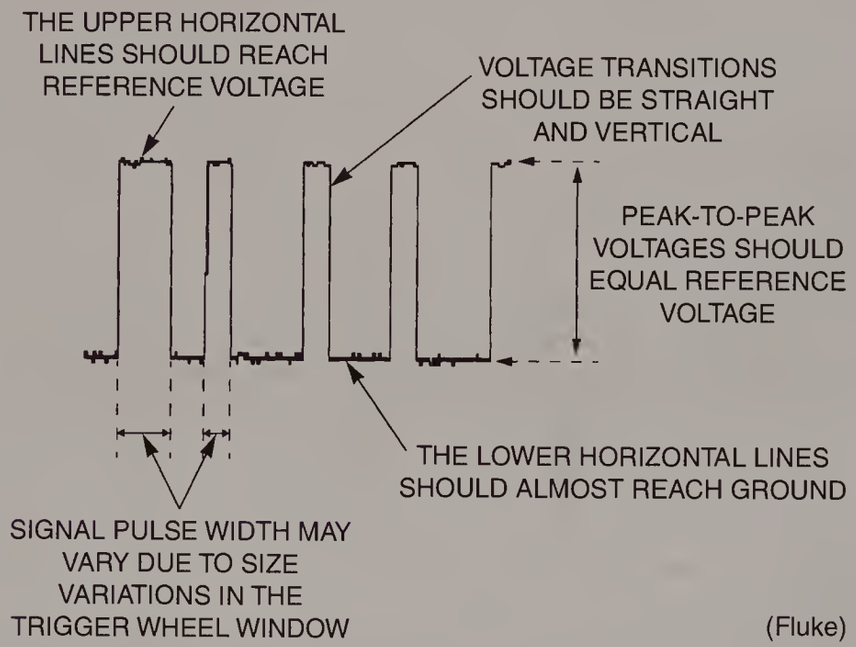
_____

28. Identify the type of sensor signal shown below.



(Fluke)

29. Identify the type of waveform shown below.



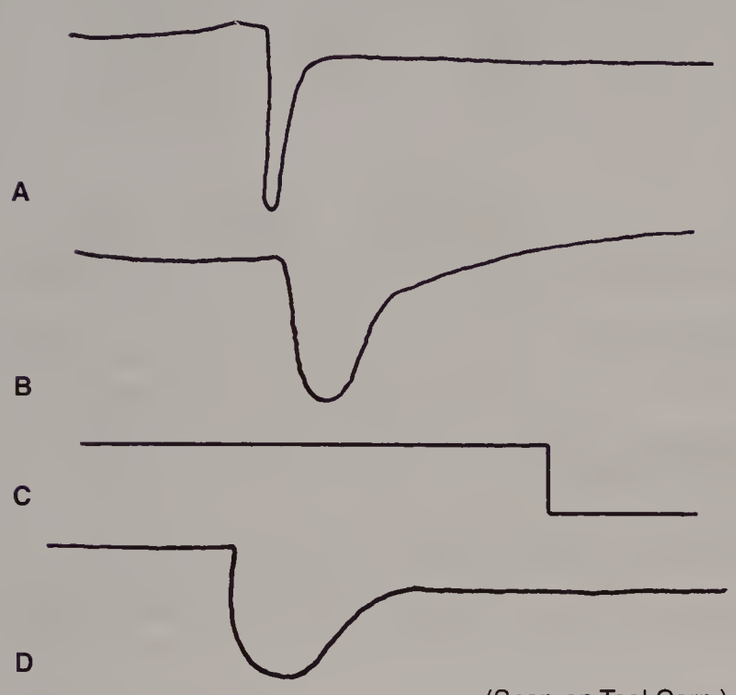
(Fluke)

30. To test a(n) _____ sensor with a scope, tap on the engine next to the sensor with a small hammer or wrench. 30. _____

Name _____

31. Identify the following waveforms for electronic injectors.

31. (A) _____
(B) _____
(C) _____
(D) _____



(Snap-on Tool Corp.)

32. A(n) _____ test stores the sensor waveform in the scope's memory when a problem occurs. 32. _____

(A) ECM
(B) flight record
(C) oxygen sensor
(D) crankshaft position

Exhaust Gas Analyzer

33. An exhaust gas analyzer will indicate excessive emissions caused by what 10 problems or conditions?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

34. Which of the following is the most modern and informative type of exhaust gas analyzer? 34. _____

(A) Two-gas.

(B) Three-gas.

(C) Four-gas.

(D) Five-gas.

35. Explain why you should never let engine exhaust fumes escape into an enclosed shop area when using an exhaust analyzer.

_____

36. List six conditions that can cause higher-than-normal HC readings.

_____

_____

_____

_____

_____

_____

37. List three typical causes of high carbon monoxide readings.

_____

_____

_____

38. List two causes of nitrogen oxide readings.

_____

_____

39. Typically, carbon dioxide readings should be above _____ %. 39. _____

(A) 2

(B) 4

(C) 6

(D) 8

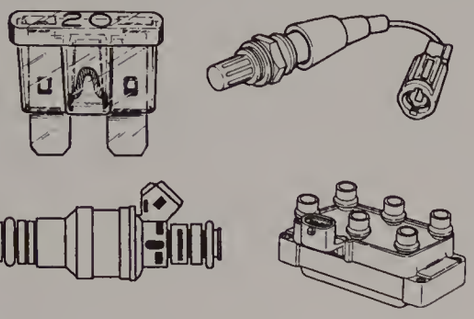
40. The _____ level in the engine exhaust sample is a good indicator of a vehicle's air-fuel mixture and a good indicator of a possible exhaust leak. 40. _____

Name _____

Date _____

Instructor _____

Score _____ Text pages 545–550



Chapter 30

ASE Electrical System Certification

After studying this chapter and completing supplemental exercises, you will be able to:

- Summarize the ASE testing program.
- Explain the Electrical/Electronic Systems Test content.
- Describe why ASE certification can be helpful to the technician and to the shop owner.
- Summarize methods of taking an ASE test successfully.

Instructions: As you study Chapter 30 of the text, complete the following workbook problems in the spaces provided.

ASE (NIASE)

1. ASE stands for: 1. _____

   (A) American Society Exam.

   (B) Automotive Service Excellence.

   (C) American System Electronics.

   (D) Automotive Sales Experience.

2. The 40-member ASE board of directors represents: 2. _____

   (A) education and consumer groups.

   (B) shop owners and aftermarket parts companies.

   (C) auto manufacturers and government agencies.

   (D) All of the above.

Voluntary Certification

3. ASE tests: 3. _____

   (A) are voluntary.

   (B) license technicians.

   (C) Both (A) and (B).

   (D) None of the above.

4. Over 500,000 technicians have taken _____ _____ tests and passed them. 4. _____

Test Categories

5. Name the eight ASE automotive test categories.

6. If you pass all of the certification test categories and meet the experience requirements, you are a: 6. _____

   (A) Certified Automobile Technician.

   (B) Master Automobile Technician.

   (C) Licensed Automobile Technician.

   (D) None of the above.

7. Explain why you should study both the theory and service chapters of this book.

ASE Tests

8. To take ASE certification tests and receive certification, you must either have _____ years of on-the-job experience or one year of approved educational credit and one year of work experience. 8. _____

9. List eight tips that might help you pass the ASE certification tests.

Name _____

10. Name three benefits of ASE certification.

_____

_____

_____

_____

_____

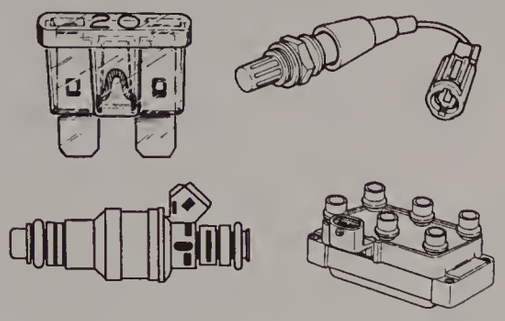
_____

Name _____

Date _____

Instructor _____

Score _____



SAMPLE ASE ELECTRICAL SYSTEM CERTIFICATION TEST

OBJECTIVE: After completing this sample test, you will be better prepared to pass the ASE Test A6, Electrical/Electronic Systems.

INSTRUCTIONS: Take the following test as you would an actual ASE Certification Test. DO NOT use your textbook. Answer all the questions in the allotted time period. Follow the test-taking techniques described in Chapter 30 of the textbook. After scoring the test, restudy the questions you answered incorrectly.The following questions are similar to the ones that may appear on the ASE test. They are not actual ASE test questions. The purpose of this sample test is to allow you to gain experience in answering these types of questions. Also, this sample test can point out the subject areas in which you may need improvement.

1. A customer drives into the shop and says his/her car is running rough. Technician A says the computer system should be checked out first. Technician B says the car should first be inspected for a more conventional problem, such as a loose vacuum hose, a bad plug wire, or a fouled plug. Who is right? 1. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

2. The malfunction indicator light on an OBD II-equipped vehicle is flashing on and off every second. Technician A says this means that the detected problem is intermittent. Technician B says this means that the detected problem could damage the catalytic converter. Who is right? 2. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

3. Which of the following is not a common location for a diagnostic connector? 3. _____

   (A) Near fuse box under dash.

   (B) Under center console.

   (C) Near inner fender panel in engine compartment.

   (D) Near left backup light in trunk.

4. Technician A says OBD II systems are designed to keep vehicles running efficiently for at least 100,000 miles. Technician B says OBD II systems are designed to detect component deterioration, not just part failure. Who is right? 4. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

5. Technician A says actuator diagnostic tests will energize specific output devices. Technician B says actuator diagnostic tests are considered nonintrusive tests. Who is right? 5. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

6. A vehicle is brought into the shop with a driveability problem. The scan tool shows the following diagnostic trouble codes: P0115, P0116, and P0119. Technician A says that these are standard OBD II trouble codes (SAE codes). Technician B says these trouble codes indicate that the problem is in the vehicle's powertrain system. Who is right? 6. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

7. After the diagnostic mode has been energized on an OBD I vehicle, the CHECK ENGINE light flashes twice, pauses momentarily, and then flashes four more times. What trouble code is indicated? 7. _____

   (A) 6.

   (B) 4.

   (C) 24.

   (D) 2.

8. Two trouble codes are displayed by a scan tool. Technician A says the problem with lowest code number should be fixed last. Technician B says that fixing the cause of the lowest code number may clear other codes. Who is right? 8. _____

   (A) A only.

   (B) B only.

   (C) Both A and B.

   (D) Neither A nor B.

Name _____

9. Where are computer terminal values tested? 9. _____

(A) At the ignition coil.

(B) At the MAP sensor.

(C) At the metal pins of the ECM.

(D) At the actuator terminals.

10. A late-model automobile has been serviced in the shop, but the diagnostic trouble codes still remain in the vehicle's computer memory. Technician A says a scan tool can be used to erase these codes from the computer's memory. Technician B says these trouble codes will generally be erased automatically after 30-50 engine starts. Who is right? 10. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

11. A computer analyzer performs all the following functions *except:* 11. _____

(A) reading trouble codes.

(B) measuring electrical values.

(C) measuring exhaust gas content.

(D) checking oil level.

12. Technician A says the test equipment shown below is a refrigerant recovery unit. Technician B says the test equipment shown below is an engine analyzer. Who is right? 12. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

(Sun Electric)

13. An engine analyzer is connected to an automobile's engine. The oscilloscope is activated. Technician A says scope voltage will appear on the screen along the horizontal axis or scale. Technician B says scope voltage will appear on the screen along the vertical axis or scale. Who is right? 13. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

14. Technician A says the scope voltage pattern for an electronic ignition will vary from the voltage pattern of a contact point type ignition system. Technician B says the scope voltage pattern for an electronic ignition will always be identical to that of a contact point type ignition system. Who is right? 14. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

15. The CO readings for a particular automobile engine are too high. Technician A says this condition may be caused by a high carburetor float setting. Technician B says this condition may be caused by a low idle speed setting. Who is right? 15. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

16. An exhaust analyzer's oxygen reading should normally be between: 16. _____

(A) 1.5 and 2.0 percent.

(B) 0.9 and 1.3 percent.

(C) 0 1 and 7 percent.

(D) 7 and 9 percent.

17. An automobile is brought into the shop. Its computer trouble codes are activated. One of the trouble codes indicates an over-rich fuel mixture. Technician A wants to check the condition of the engine oil to see if it is having an effect on the oxygen sensor's operation. Technician B says the condition of engine oil will not have any effect on oxygen sensor performance. Who is right? 17. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

Name _____

18. What is the most common cause of electrical-related problems in a computer system? 18. _____

    (A) Dead battery.

    (B) Faulty ECU.

    (C) Sensor malfunction.

    (D) Poor electrical connections.

19. Technician A says a reference voltage of five volts is normally fed to switching and variable-resistance sensors. Technician B says a reference voltage of .2 volts is normally fed to switching and variable-resistance sensors. Who is right? 19. _____

    (A) A only.

    (B) B only.

    (C) Both A and B.

    (D) Neither A nor B.

20. Technician A says a faulty engine speed sensor will not keep an engine from running. Technician B says a faulty engine speed sensor will sometimes keep an engine from running. Who is right? 20. _____

    (A) A only.

    (B) B only.

    (C) Both A and B.

    (D) Neither A nor B.

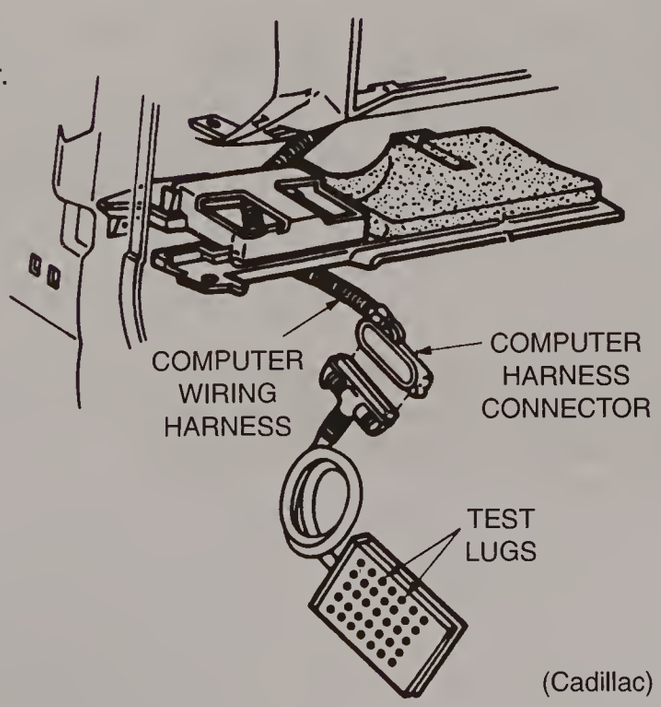
21. What type of computer system test equipment is being used in the illustration below? 21. _____

    (A) Digital ohmmeter.

    (B) Diagnostic computer analyzer.

    (C) Breakout box.

    (D) Analog voltmeter.



(Cadillac)

22. Technician A says a bad vehicle speed sensor will always keep an engine from running. Technician B says a bad vehicle speed sensor will normally reduce engine performance and fuel economy. Who is right? 22. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

23. How long are oxygen sensors normally designed to last? 23. _____

(A) 100,000 miles.

(B) 50,000 miles.

(C) 25,000 miles.

(D) 10,000 miles.

24. Which of the following will not cause oxygen sensor contamination? 24. _____

(A) Leaded fuel.

(B) Silicone.

(C) Carbon.

(D) Carbon monoxide.

25. Which of the following oxygen sensor output values would indicate a lean air-fuel ratio? 25. _____

(A) 0.4 volts.

(B) 1 volt

(C) 2.4 volts.

(D) 5 volts.

26. Technician A wants to use a low-resistance meter to measure oxygen sensor voltage. Technician B wants to use a high-impedance, digital meter to measure oxygen sensor voltage. Who is right? 26. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

27. An oxygen sensor has been removed for inspection. The sensor's tip is light gray in color. Technician A says this indicates lead contamination, which requires sensor replacement. Technician B says this is a normal color for an oxygen sensor. Who is right? 27. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

Name _____

28. Technician A says a bad manifold pressure sensor can affect the air-fuel ratio when the engine accelerates and decelerates. Technician B says a bad manifold pressure sensor can possibly affect ignition timing. Who is right? 28. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

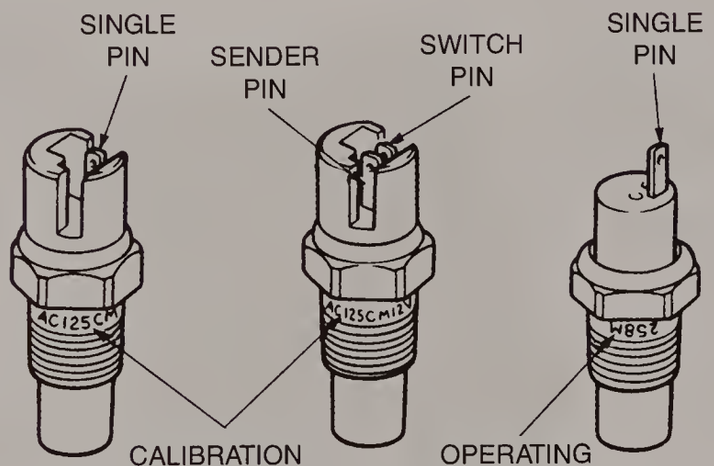
29. What type of engine sensors are shown in the following illustration? 29. _____

(A) Oxygen sensors.

(B) Coolant temperature sensors.

(C) Air temperature sensors.

(D) Manifold absolute pressure sensors.



(Pontiac)

30. Technician A says a faulty knock sensor can affect ignition timing. Technician B says a faulty knock sensor can affect turbocharger boost pressure. Who is right? 30. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

31. Technician A says a diesel metering valve sensor is only used on diesels equipped with computer control. Technician B says a diesel metering valve sensor has been used on diesels for the last twenty years. Who is right? 31. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

32. An automobile with multi-point injection is being serviced. A stethoscope is being used to test injector operation. Technician A says if there is a clicking sound from each injector, the injectors are electrically good. Technician B says if there is a clicking sound from each injector, the voltage supply to the injectors is below normal. Who is right? 32. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

33. In what position should the ignition key be during computer removal? 33. _____

(A) "On" position.

(B) "Off" position.

(C) "Accessory" position.

(D) "Run" position.

34. A fully charged battery should have a hydrometer reading of at least: 34. _____

(A) 8.256.

(B) 5.760.

(C) 1.265.

(D) 0.765

35. Which of the following battery tests is the most informative? 35. _____

(A) Battery voltage test.

(B) Battery load test.

(C) Battery hydrometer test.

(D) None of the above.

Name _____

36. An automobile is brought to the shop with a no-crank problem. Technician A says this condition may be due to a discharged battery. Technician B says this condition may be due to a bad electrical connection. Who is right? 36. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

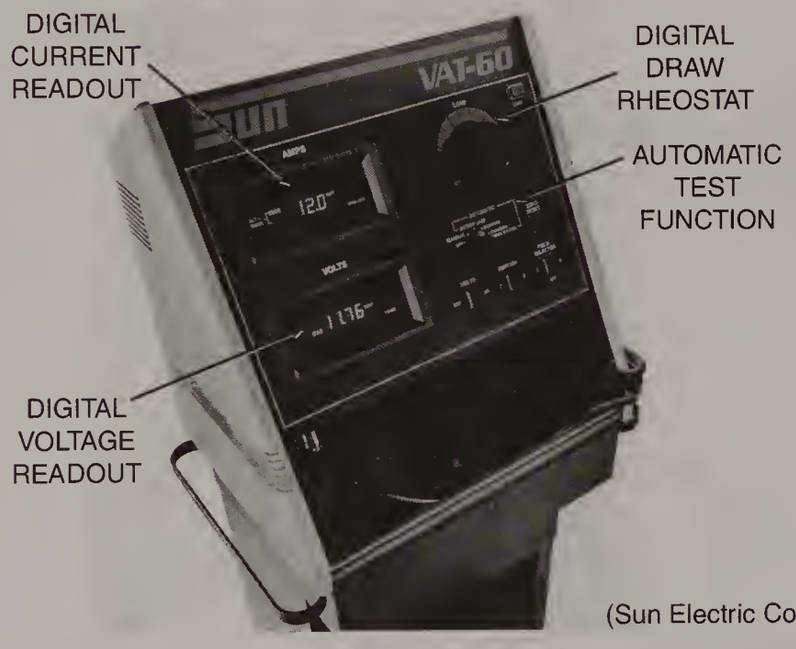
37. What type of battery service equipment is shown in the illustration below? 37. _____

(A) Digital voltmeter.

(B) Load tester.

(C) Boost charger.

(D) None of the above.



(Sun Electric Corp.)

38. The purpose of a starter current draw test is to measure: 38. _____

(A) input voltage at the starter motor.

(B) input voltage at the starter solenoid.

(C) the number of amps used by the starting system.

(D) the maximum current produced by the battery.

39. Technician A says a charging system output test measures the current and voltage output of the charging system while under a load. Technician B says a charging system output test measures the voltage output of the alternator. Who is right? 39. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

40. A regulator bypass test has been performed on an automobile's charging system. When the regulator is bypassed, charging system voltage and current increase to normal. Technician A says this indicates a faulty alternator. Technician B says this indicates a faulty regulator. Who is right? 40. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

41. An automobile's engine cranks, but will not start. Technician A says a "spark test" will determine the general condition of the ignition system. Technician B says a "spark test" can only determine the general condition of the engine's ignition system primary circuit. Who is right? 41. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

42. The purpose of a secondary wire resistance test is to check the general condition of: 42. _____

(A) the ignition system wiring leading to the ignition control module.

(B) the ignition system wiring leading to the pickup coil.

(C) a spark plug or coil wire conductor.

(D) spark plug or coil wire insulation.

43. Technician A says bad spark plugs can produce hard starting problems for an engine. Technician B says bad spark plugs can produce lack of power problems for an engine. Who is right? 43. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

Name _____

44. A properly burning spark plug should have a: 44. _____

(A) black or dark-blue color.

(B) brown to grayish-tan color.

(C) white or light-yellow color.

(D) orange or light-red color.

45. Technician A says while an engine is cranking, a high DC voltage should be produced by the pickup coil. Technician B says while an engine is cranking, a low AC voltage should be produced by the pickup coil. Who is right? 45. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

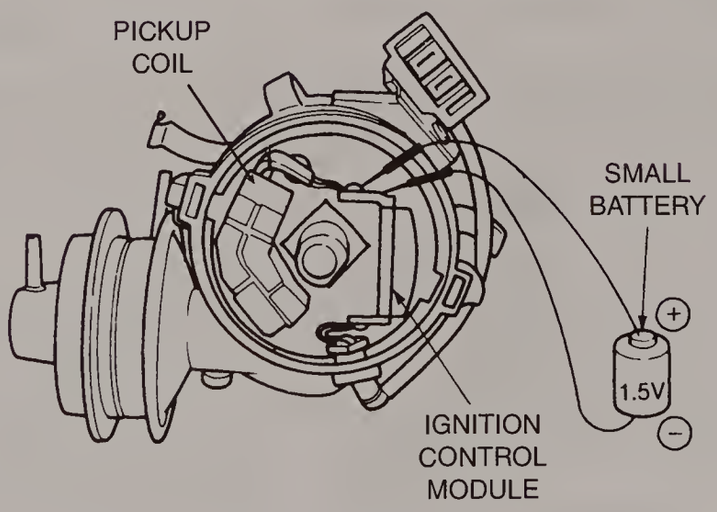
46. Technician A says the test procedure shown in the illustration below is used to check the operating condition of a pickup coil. Technician B says the test procedure shown in the illustration below is used to check the operating condition of the ignition control module. Who is right? 46. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.



47. Technician A says an ignition supply voltage test measures the amount of voltage going to the positive terminal of the ignition control module. Technician B says an ignition supply voltage test measures the amount of voltage going to the positive terminal of the ignition coil. Who is right? 47. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

48. Technician A says when an automobile's lights dim, a high resistance in the circuit is causing the problem. Technician B says when an automobile's lights dim, a low voltage supply is causing the problem. Who is right? 48. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.

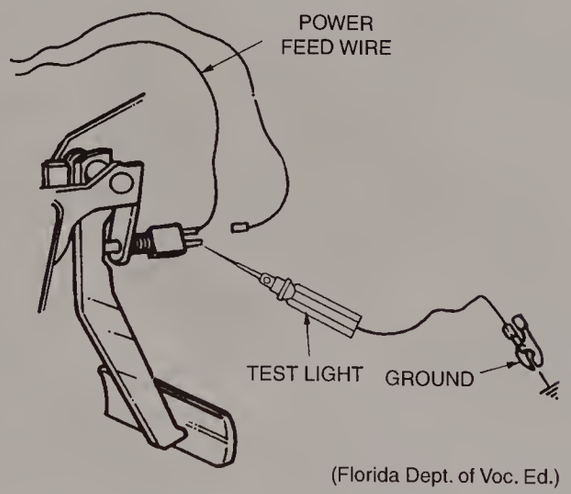
49. What type of automobile electrical service procedure is shown in the illustration below? 49. _____

(A) Testing operation of neutral safety switch.

(B) Testing operation of brake light switch.

(C) Testing operation of hazard warning flasher assembly.

(D) Testing the operation of emergency brake switch.



(Florida Dept. of Voc. Ed.)

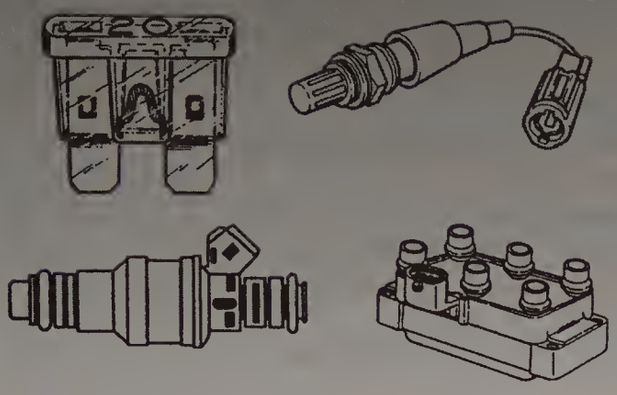
50. Technician A says a poor ground can cause some types of car radio interference. Technician B says a bad spark plug wire can cause some types of car radio interference. Who is right? 50. _____

(A) A only.

(B) B only.

(C) Both A and B.

(D) Neither A nor B.



Instructions for Performing Workbook Jobs

The jobs in this workbook are designed to supplement the material in the textbook by outlining various hands-on activities. Before starting any job, read through the entire assignment and discuss the procedure with your instructor. It is also important to read the related chapters in the textbook and review all pertinent safety information.

The jobs in this workbook are numbered primarily for ease of reference. The numbers do not necessarily dictate the order in which the jobs must be performed. Some jobs can be done as part of other, more complex jobs. The order in which the jobs are performed is entirely up to your instructor.

Some jobs may take more than one class period to complete. When this occurs, be sure to inform your instructor so your project can be stored properly until you are able to resume work.

As you complete each step in a job, place a checkmark in the corresponding box. This will help you keep track of your progress. If any of the steps in a given job do not apply to the particular vehicle or assembly you are working on, mark N/A, for not applicable, by the box. When you finish an entire job, ask your instructor to inspect your work and initial your completed job sheet.

Tools and Materials List

The following is a list of the tools and materials that are used or may be used in the following jobs. In addition to the tools listed here, other special service tools may be specified in the manufacturer's service information. Also, replacement parts will be required on an as-needed basis.

Hand Tools

(Contained in individual sets or the tool crib in sufficient quantities to permit efficient instruction)
Adjustable Wrench—6″ and 12″
Air Blow Gun (meeting OSHA requirements)
Allen (Wrench or Socket) Set—Standard (.050″–3/8″)
Allen (Wrench or Socket) Set—Metric (2mm–7mm, 10mm, 12mm)
Battery Post Cleaner
Battery Terminal Pliers
Battery Terminal Puller
Brake Spoon
Chisels:
- Cape 5/16″
- Cold 3/8″, 3/4″

Chisel Holder
Claw Type Pickup Tool
Combination Wrenches:
- Standard (1/4″–1 1/4″)
- Metric (7mm–24mm)

Crowfoot Wrench Set—Metric
Crowfoot Wrench Set—Standard
Ear Protection
Feeler Gauge (Blade Type):
- .002″–.040″
- .006mm–.070mm

Files:
- Coarse 6″ and 12″
- Fine 6″ and 12″
- Half Round 12″
- Round 6″ and 12″

Flare Nut (tubing) Wrenches:
- 3/8″–3/4″
- 10mm–17mm

- Flashlight
- Fuse Puller
- Hack Saw
- Hammers:
  - 16 oz. Ball Peen
  - Brass
  - Dead Blow Plastic Mallet
  - Plastic Tip
  - Rubber Mallet
- Inspection Mirror
- Jumper Wire Set (with various adapters)
- Magnetic Pickup Tool
- Pliers:
  - Combination 6"
  - Hose Clamp
  - Locking Jaw
  - Needle Nose 6"
  - Side Cutting
  - Slip Joint (Water Pump)
- Pry Bars:
  - Rolling Head
  - Straight
- Punches:
  - Center
  - Brass Drift
  - Pin 1/8", 3/16", 1/4", 5/16"
  - Taper 3/8", 1/2", 5/8"
- Safety Glasses (meeting OSHA requirements)
- Scraper:
  - Carbon 1"
  - Gasket 1"
- Screwdriver—Blade Type:
  - Stubby
  - 6", 9", 12"
  - Offset
- Screwdriver—Phillips:
  - Stubby #1, #2
  - 6" #1, #2
  - 12" #3
  - Offset #2
- Screwdriver—Impact Driver Set
- Screw Starter:
  - Phillips
  - Standard
- Socket Set—1/4" Drive:
  - 1/4"–1/2" Standard Depth
  - 1/4"–1/2" Deep
  - 6mm–12mm Standard Depth
  - 6mm–12mm Deep
  - Flex/Universal Type
  - 3", 6" Extensions
  - Ratchet
- Socket Set—3/8" Drive:
  - 5/16"–3/4" Standard Depth (6 point)
  - 3/8"–3/4" Deep (6 point)
  - 10mm–19mm Standard Depth
  - 10mm–19mm Deep
  - 3", 5", 10" Extensions
  - Flexhead Ratchet
  - Ratchet
  - Spark Plug Sockets 5/8", 13/16"
  - Speed Handle
  - Universal Joint
  - Flexible Socket Set 3/8"–3/4"
  - Flexible Socket Set 10mm–19mm
- Socket Set—1/2" Drive:
  - 7/16"–1 1/8" Standard Depth
  - 7/16"–1 1/8" Deep
  - 10mm–24mm Standard Depth
  - 10mm–24mm Deep
  - 3", 6", 12" Extensions
  - Flex Handle (Breaker Bar)
  - Ratchet
- Spark Plug Feeler Gauge (Gap Tool)
- Tape Measure—Standard and Metric
- Test Light (12V)
- Tire Pressure Gauge
- Torque Wrench:
  - 3/8" Drive (10–250 lb in)
  - 3/8" Drive (5–75 lb ft)
  - 1/2" Drive (50–250 lb ft)
- Torx® Set (screwdrivers and/or sockets):
  - T-8 to T-60
  - Wire Brush

General Lab/Shop Equipment

- Air Chisel Set (various bits)
- Air Compressor and Hoses
- Air Pressure Regulator
- Air Ratchet (3/8" drive)
- Automotive Stethoscope (electronic recommended)
- Axle Stands (safety stands)
- Battery Charger
- Battery/Starter/Charging System Tester
- Bearing Packer (hand operated)
- Belt Tension Gauge
- Bench or Pedestal Grinder
- Compression Tester
- Computer Scan Tool (handheld) or Personal Computer (PC) with interface capability for on-board diagnostics (OBD II compliant recommended)
- Coolant/Combustion Gas Detector (recommended)
- Coolant Tester
- Cooling System Pressure Tester and Adapters
- Constant Velocity Joint (CV) Service Tools:
  - Boot Installation Tool
  - Boot Clamp Pliers or Crimping Ring
- Creeper
- Cylinder Leakage Tester
- Dial Indicator with Flex Arm and Clamp Base
- Digital Multimeter with various lead sets

Drain Pans
Drill—3/8″ variable speed, reversible
Drill—1/2″ variable speed, reversible
Electric Heat Gun
Engine Coolant Recovery Equipment or Recycler or Coolant
Disposal Contract Service
Extension Cords
Face Shields
Fender Covers
Floor Jack (1 1/2″ ton minimum)
Handheld Vacuum Pump
Hoist(s)
Hydraulic Press with adapters
Impact Socket Sets—3/8″ Drive (standard and metric)
Impact Sockets—1/2″ Drive (7/16″–1 1/8″)
Impact Sockets—1/2″ Drive (12mm–24mm)
Impact Sockets—1/2″ Drive Deep (30 mm, 32 mm, 36mm)
Impact Wrench—1/2″ Drive
Impact Wrench—3/8″ Drive
Jumper Cables
Master Puller Set
Micrometer (depth)
Micrometers—0–1″, 1–2″, 2–3″, 3–4″, 4–5″ (outside type)
Oil Can—Pump Type
Oil Filter Wrench
Oxyacetylene Torch
Parts Cleaning Tank and Gloves (on-solvent based cleanser suggested)
Remote Starter Switch
Screw Extractor Set
Seat Covers
Snap Ring Pliers Set—External
Snap Ring Pliers Set—Internal
Soldering Gun
Soldering Iron (25-watt, pencil tip)
Spark Plug Boot Puller
Tach/Dwell Meter
Tap and Die Set—Standard
Tap and Die Set—Metric
Thread Repair Insert Kit
Tire Inflator Chuck
Trouble/Work Lights (fluorescent preferred)
Tube Quick Disconnect Tool Set
Tubing Bender
Tubing Cutter/Flaring Set (double-lap and ISO)
Twist Drill Set—1/64″–1/2″
Valve Core Removing Tool
Vernier Calipers:
    0–6″
    0–125mm
Waste Oil Receptacle with extension neck and funnel
Wheel Chocks
Workbenches with vises

Specialty Tools and Equipment

Battery Hydrometer
Connector Pick Tool Set
Door Panel Trim Tool(s)
Headlight Aimer or Screen
Wire and Terminal Repair Kit
Engine Analyzer (with ignition display capability)
Four or Five Gas Exhaust Analyzer
Fuel Injection Pressure Gauge Sets with Adapters
Injector Pulse Tester
Logic Probe (suggested)
Oxygen Sensor Socket
Pinch-off Pliers
Sending Unit Socket(s)
Spark Plug Thread Tap
Spark Tester
Timing Advance Light

Additional Materials

Applicable service manuals or information system
Approved lubricants
Approved parts cleaners
Chemical sealers and adhesives
Miscellaneous replacement gaskets
Miscellaneous replacement seals

Job 1

Name: _____

Date: _____

Instructor: _____

Score: _____

Shop Safety

Objective: With access to the auto shop, you will learn to locate and use fire extinguishers, the fire exit, safety glasses, and other shop safety equipment.

Tools and Equipment: Obtain a floor jack and jack stands.

Instructions: Study Chapter 10 in the text before starting this job. As you read the instructions, answer the questions and complete the tasks. Ask your instructor for any added details.

Eye Protection

Safety glasses or goggles should be worn in the shop *at all times.* Safety glasses are fine for most tasks. Goggles are preferred when there is a chance of a chemical being splashed in your face. A full-face shield is best when debris could be thrown toward your face. Welding goggles have dark lenses that protect your eyes from the bright light of a welding flame or arc.

1. What types of eye protection are available in your shop? _____

   _____

   _____ Completed ❑

2. Where are the safety glasses and goggles kept in your shop? _____

   _____

   _____ Completed ❑

Clothing Safety

Always dress for safety. Loose clothing, jewelry, and long hair are very dangerous. They can be caught in drum lathes, wheel balancers, engine fans, a drill press, and other spinning objects.

Wear protective safety shoes. Tennis shoes and sandals are *not* safe in an auto shop. If a heavy part (engine flywheel, brake drum, etc.) were dropped on an unprotected foot, serious injury could result.

3. Are you properly dressed to work? _____

   Explain. _____

   _____

   _____ Completed ❑

Battery Safety

Batteries can explode. Keep sparks and flames away from all batteries, especially during charging. Hydrogen gas is produced by batteries as part of their chemical reaction. If ignited, this gas can explode, possibly throwing the battery case and acid into your face.

4. Explain how to safely connect jumper cables to a vehicle's battery. _____

   _____

   _____

   _____ Completed ❑

5. When connecting a battery charger, what safety precautions should you take?_____

_____

_____

_____

_____

_____ Completed ❑

Fire Safety

Always take precautions to minimize the risk of fire. Store oily rags and gasoline in safety cans. Wipe up spilled gasoline and oil immediately. Hold a rag around the fitting when removing a vehicle's fuel line. Relieve fuel pressure before working on fuel injection systems. Remember, if you are badly burned, you can be scarred for life, blinded, or even killed. A few seconds can be a lifetime during a fire.

6. Walk around the shop and locate all fire extinguishers, fire exits, and fire alarms. Completed ❑

7. Where are the fire extinguishers located?_____

_____

_____ Completed ❑

8. Where are the fire alarms located? _____

_____

_____ Completed ❑

9. Explain how to properly exit the shop in case of a fire._____

_____

_____ Completed ❑

Grinder and Drill Press Safety

If misused, an electric grinder can cause serious injuries to your eyes, face, and hands. Always keep the tool rest adjusted close to the grinding wheel. Hold small objects with vise-grip pliers. Wear a face shield and thick leather gloves. Keep the tool rest in position close to the wheel. Be careful not to strike the grinding wheel. It can shatter and explode when spinning.

10. Inspect the electric grinder closely. Locate the power switch. Check the position of the tool rest. Make sure all guards and shields are in place. Also, check the condition of the grinding wheel. Completed ❑

11. Is the electric grinder in your shop safe? _____

Explain. _____

_____ Completed ❑

12. Locate and inspect the operation of your shop's drill press. Find the on/off button, feed lever, chuck, and other components. Completed ❑

Warning!
Never leave the chuck key in the drill chuck. If the drill press is accidentally turned on, the chuck key could fly out and hit someone.

13. How should a workpiece be secured on the drill press?_____

_____

_____

_____ Completed ❑

Compressed Air Safety

Use compressed air with caution. Shop air hoses can have more than 100 psi (689 kPa) air pressure. If abused, this is enough pressure to blind, deafen, or even kill. *Never* point an air nozzle at yourself or anyone else.

14. What is the air pressure setting on your shop compressor? _____

_____ Completed ❑

Shop Cleanliness

The auto shop floor must be kept clean at all times. Oil or water on the floor could cause a serious fall or injury. Wipe up or place quick dry (oil absorbent) on spilled oil or antifreeze. Use a squeegee and rags to remove spilled water. When your hands become oily or greasy, wash them off or wipe them dry with a clean rag.

Never leave tools, creepers, or parts on the floor. Place them on, against, or under the workbenches. You can judge a technician by the condition of his or her tools and work area. If a technician looks sloppy, he or she probably does sloppy work.

15. Is the shop area clean and organized? _____

List any unsafe conditions found. _____

_____

_____ Completed ❑

Carbon Monoxide

When an engine is running, it produces carbon monoxide, a colorless, odorless, toxic gas. Always install an exhaust hose over the tailpipe of a vehicle running in an enclosed shop, **Figure 1.** Make sure the shop's exhaust ventilation system is on.

Figure 1. Place an exhaust hose over tailpipe of any vehicle running in enclosed shop. This will prevent shop from filling with poisonous fumes.

16. Where are the exhaust hoses in your shop? _____

_____

_____ Completed ❑

17. Where do you turn on the fan for the shop's exhaust ventilation system?_____

_____

_____ Completed ❑

Tool Safety

Tool safety involves keeping your tools clean and well maintained. Greasy or oily tools are very dangerous. Your hand could slip, causing serious injury. Always wipe off your tools with a clean shop rag after use and organize them neatly in your toolbox. Tool safety also involves selecting the right tool for the job. If you are using the wrong tool, an accident is more likely to occur.

18. Where are your tools stored?_____

_____

_____ Completed ❑

Floor Jack and Jack Stand Safety

Warning!
Never work under a vehicle supported only by a floor jack. If someone were to hit the jack handle or a jack seal were to fail, the vehicle could fall and crush you. Use jack stands to secure the vehicle before working under it. See **Figure 2.**

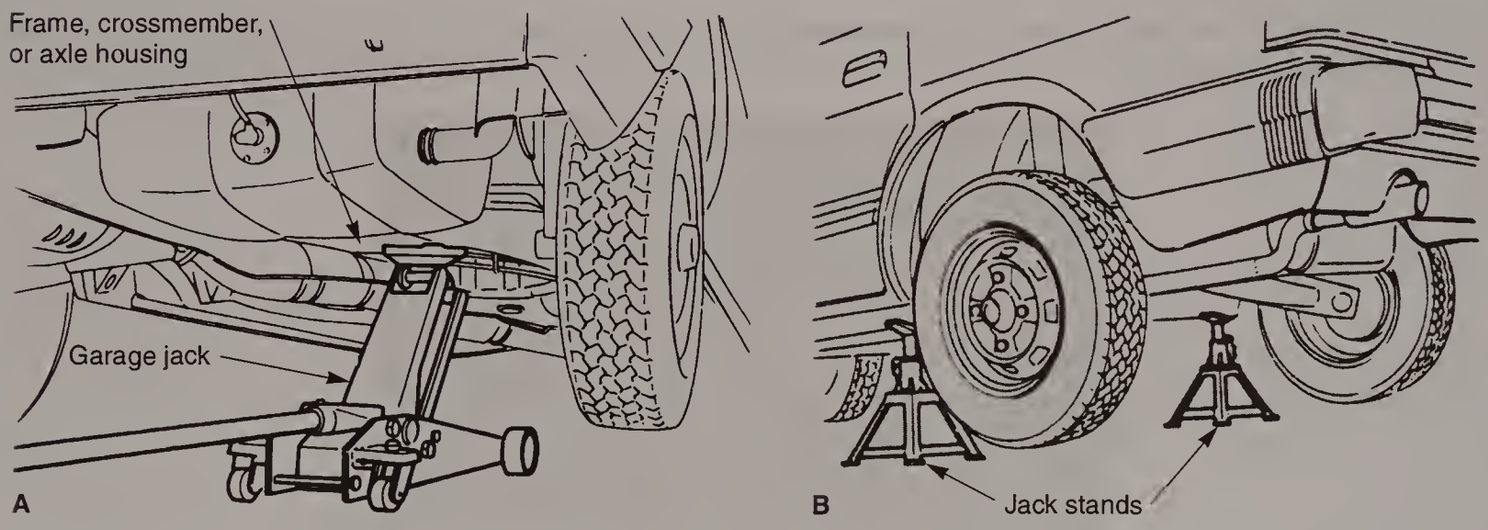


Figure 2. Never work under a vehicle supported only by a floor jack. A—A jack is used only for initial lifting. B—Jack stands must be used to secure the vehicle before working under it. Place them under recommended lift points. (Subaru)

19. *Without* lifting a vehicle, practice operating a floor jack. Close the valve on the jack handle. Pump the handle up and down slowly. It is important that you know how to control the lowering action of the jack. This will help you safely lower a vehicle onto the jack stands. Completed ❑

20. After getting your instructor's approval, place the jack under a proper lift point on the frame, rear axle housing, suspension arm, or reinforced unibody section. Completed ❑

Note!
If in doubt about where to position the jack, refer to a service manual for the vehicle at hand. Lifting instructions are usually given in one of the front sections of the manual.

21. Make sure the vehicle is on a level shop floor and will not roll. Place the transmission in neutral and release the emergency brake. This will let the vehicle roll slightly as it is raised. If the vehicle cannot roll and the small wheels on the jack catch in the shop floor, the vehicle could slide off the jack saddle. Completed ❑

22. Pump the jack handle slowly to raise the vehicle. Completed ❑

23. When the vehicle is high enough, place jack stands under the suggested lift points. Lower the vehicle slowly onto the stands. Check that they are safe. Then, block the wheels, place the transmission in park, and apply the emergency brake. Finally, remove the floor jack. It should now be safe to work under the vehicle. Completed ❑

24. Raise the vehicle and remove the jack stands. Lower the vehicle to the floor and return the equipment to its storage areas. Completed ❑

25. Where did you position the floor jack saddle when raising this particular vehicle?

_____

_____ Completed ❑

Lift Safety

Most shops have a lift for raising vehicles during repairs. If used improperly, a lift can be very dangerous. The vehicle could fall off the lift.

26. *After* obtaining permission from your instructor, raise your shop lift (no vehicle on it). Practice raising it slowly and steadily. Completed ❑

27. Where is the control for raising and lowering the lift? _____

_____

_____ Completed ❑

28. Position a vehicle on the lift so its center of gravity is over the center of the lift. Position the lift arms on the recommended lift points under the vehicle. Raise the vehicle until the tires are about an inch off the shop floor. Completed ❑

29. Go to the front and jounce the vehicle a few times. There should be no substantial movement or noise from the vehicle leaving the lift pads. If the vehicle does not seem secure, lower it to the ground and recheck the lift arm placement. Completed ❑

30. If the lift arms are positioned properly, continue to raise the vehicle slowly. When the vehicle is in the air, double-check that the safety leg or catch has kicked out, **Figure 3.** This will ensure the lift does not drop with a loss of air pressure or other failure. Completed ❑

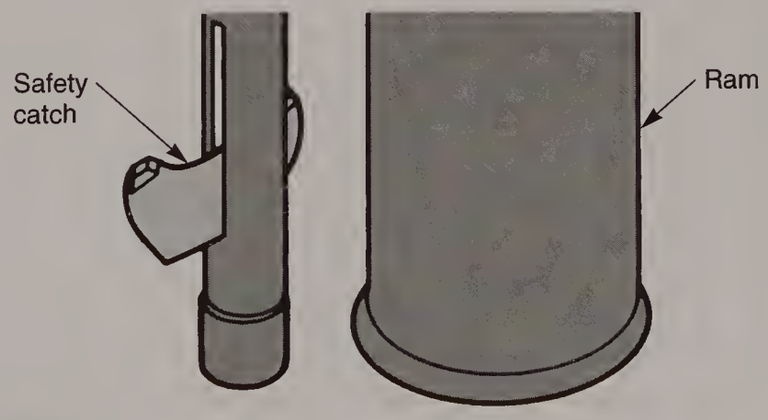


Figure 3. Most lifts have a safety catch. Make sure it is engaged before working under vehicle.

Air Bag Safety

An air bag can be dangerous if mishandled. By following some simple rules, air bags can be safely serviced. When servicing a vehicle that has an undeployed air bag, follow the manufacturer's instructions for disarming the system. You should disarm the system when installing a new air bag.

31. List the precautions that should be taken when working with air bags.

_____

_____

_____

_____ Completed ❑

32. Summarize the procedure for disarming an air bag on a particular late-model vehicle.

_____

_____

_____

_____

_____ Completed ❑

33. Clean your work area and return all tools to their proper storage locations. Completed ❑

34. Ask your instructor to sign this job.

Instructor's Signature _____

Job 2

Name: _____

Date: _____

Instructor: _____

Score: _____

Using Digital Multimeters

Objective: After completing this job, you will be able to properly use a digital multimeter to complete electrical tests.

Tools and Equipment: You will need a digital multimeter, access to a vehicle or battery and battery charger, piece of wire and vacuum hose, ballast resistor or thermistor, eight spark plug wires, jumper wires, light socket and bulb, an on/off switch, three alternator diodes, three ignition system pickup coils, and your textbook.

Instructions: Study textbook Chapters 6 and 9 before doing this job. It will give you information essential to the full understanding of this learning exercise. Ask your instructor for the location of the equipment to be used for added details. Only connect the circuits and tests described. This job may require more than one class period.

Digital Multimeters

1. Check out the multimeter and study its controls. It will have settings for different measurements and scales. It is important that you have the meter set properly *before* connecting it to a source of voltage or current.

   Completed ❑

2. You will be using the ohmmeter part of your multimeter first. Set the meter controls to measure resistance.

   Completed ❑

3. Measure the resistance of the following components.

   Piece of wire = _____ ohms

   Piece of rubber hose = _____ ohms

   Completed ❑

4. Using what you learned in the text about conductors and insulators, explain your ohmmeter readings for Step 3.

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   _____

   Completed ❑

Resistance Measurement

5. A ballast resistor or thermistor can be used to control the amount of current flowing into a circuit, depending on temperature. Both a thermistor and ballast resistor's internal resistance is altered by temperature. Measure and record the resistance of your ballast resistor or thermistor at room temperature.

   Ballast resistor or thermistor = _____ohms

   Completed ❑

6. Touch your ohmmeter leads on each resistor or thermistor terminal. If you were to heat either device, its ohm value would change. When testing the ballast resistor or thermistor, you would compare your ohm value to specifications.

   Completed ❑

7. For this job, assume that specifications call for your ballast resistor or thermistor to have between 10–12 ohms at room temperature. Would the resistor or thermistor you tested be good or bad? _____

Explain: _____

_____

_____

_____

_____

_____

_____ Completed ❑

Testing Spark Plug Wires

A good spark plug wire should *not* have excessive resistance (depending on manufacturer, below 25,000–100,000 ohms). When the carbon strands in the center of a spark plug wire fail, the resistance of the plug wire will increase tremendously.

A defective plug wire will often have an almost infinite amount of resistance, and current will not flow through the wire. The engine cylinder with the bad plug wire will develop a "dead miss," and the engine will idle roughly.

8. Locate the numbered spark plug wires. Measure the resistance of the wires to determine if they are defective. Record your results in the following chart. Completed ❑

Spark plug wire	1	2	3	4	5	6	7	8
Resistance								

9. How many spark plug wires were good? _____ Completed ❑

10. How many spark plug wires were defective? _____ Completed ❑

Diode Testing

A diode is an electrical check valve. It will allow current to flow in one direction only. The condition of a diode can be tested with an ohmmeter.

A good diode will show high resistance with the meter leads connected in one direction and low resistance with the meter leads reversed. A bad diode may be either open or shortened. An open diode will exhibit an extremely high resistance when tested in both directions. A shorted diode will have low resistance in both directions.

11. Measure the resistance of three diodes. Connect the ohmmeter leads in both directions and record your readings in the chart below. Unless instructed otherwise, set your ohmmeter range switch to resistance. Some meters have test settings specifically designed for testing diodes. Completed ❑

Diode	1	2	3
Forward reading			
Reverse reading			

12. Explain the condition of the diodes tested in the previous step. _____

_____

_____

_____ Completed ❑

Pickup Coil Testing

A pickup coil is one of the more problem prone components in an electronic ignition or computer system. Due to heat, cold, vibration, and movement, coil windings and output wires can break. When this happens, the ignition or computer system can malfunction.

13. Connect an ohmmeter to the pickup coil as shown in **Figure 1.** Depending on the manufacturer, the resistance specification for your pickup coils may vary from 150–1500 ohms. Wiggle the pickup coil wires and tap the coil with a screwdriver. If the ohmmeter reading does not remain steady and within specifications, replace the pickup coil. Completed ❑

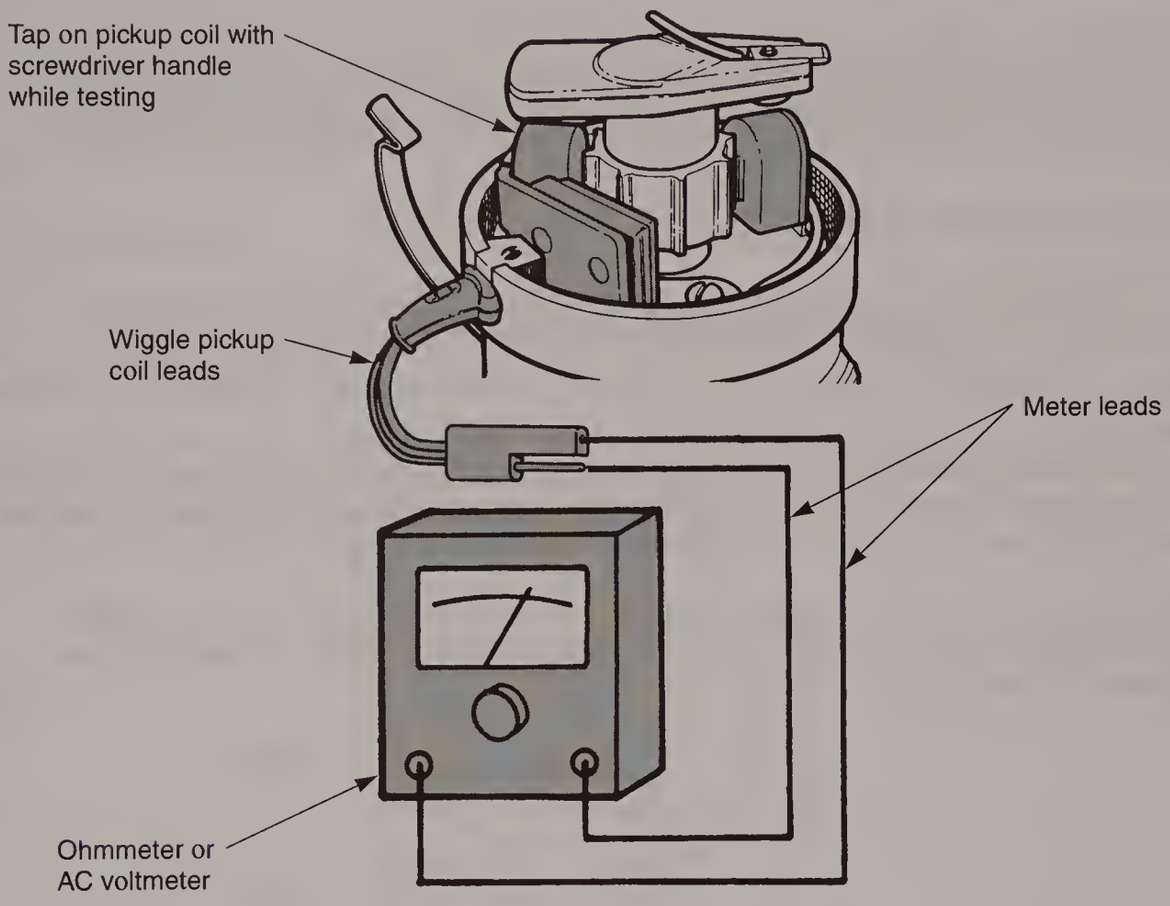


Figure 1. Connect an ohmmeter to leads from the pickup coil. (DaimlerChrysler)

14. Measure and record the resistance of three pickup coils. It is a good idea to *wiggle* the pickup coil's output wires while testing. An internal wire break may only show up when the wires are moved. Completed ❑

Pickup coil	1	2	3
Ohmmeter reading			

15. Explain the condition of the pickup coils._____

_____

_____

_____ Completed ❑

16. Have your instructor sign this sheet for credit on this section of the job. Completed ❑

Instructor's Signature _____

Measuring Voltage

17. Set your meter to measure dc volts. If the meter is capable of measuring volts on a scale, make sure the meter is set to read at least 15 volts dc. A voltmeter, as with any meter, must always be set to measure slightly more than the expected maximum value. This will prevent the meter from being damaged. Completed ❑

18. With the engine off, connect your test leads across the battery posts. *Do not* reverse your leads or meter damage could occur. The red meter lead should go to positive; the black lead should go to negative. Completed ❑

19. What is the voltage of your battery?

_____ Completed ❑

20. Connect a battery charger (trickle charger) to the battery. Measure the voltage across the battery posts with the charger *on*. For a battery to be charged, it must have an input voltage higher than its standing potential of 12.6 volts. By forcing voltage into the battery, the battery can be returned to a full state of charge. Completed ❑

21. What was your charging voltage reading?

_____ Completed ❑

22. How much higher was the charging voltage reading than the standing battery voltage (step 19)?

_____ Completed ❑

Note!
Whenever you think of voltage, relate it to water pressure. Voltage is the force that pushes electrons (electricity) through a circuit. It is much like the pressure that pushes water through a garden hose. As water pressure is increased, the amount of flow (current) and the distance that the water will spray is increased.

23. Connect the light circuit as shown in **Figure 2.** Take your time and try to keep everything organized. Avoid winding all the wires into a confusing bundle. Make sure that none of your "hot wires" are touching ground and shorting out. Completed ❑

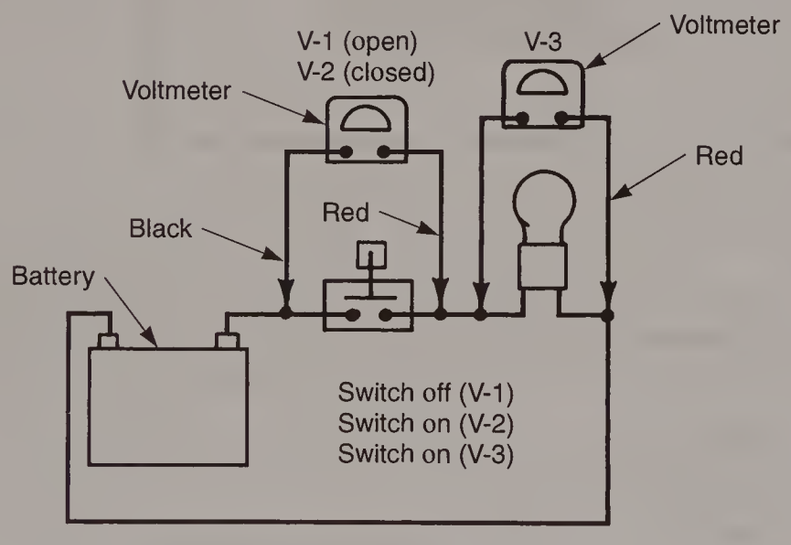


Figure 2. Study required voltage measurements.

24. Before trying your circuit or connecting your meter, ask your instructor to check your work. Completed ❑

25. After obtaining instructor approval, turn on the switch. The lightbulb should light every time the circuit path is connected with the switch. If not, recheck your connections and bulb. Completed ❑

26. Connect your voltmeter as shown in V-1 of **Figure 2.** Leave the switch open. Completed ❑

27. Record your meter readings in the chart. Then with the switch closed (on), repeat this process on the other two voltage drop measurements (V-2 and V-3). Completed ❑

Voltmeter Connection	V-1 Switch Off	V-2 Switch On	V-3 Switch On
Reading			

A voltage drop is an indicator of circuit resistance. For example, the voltage drop across an open switch represents full battery voltage. The voltage drop across a closed switch will be zero.

A voltage drop is proportional to the internal resistance of the tested circuit or component (open switch = infinite resistance = maximum voltage drop and a closed switch = zero resistance = zero voltage drop). In many instances, a voltmeter (voltage drop) is much easier, faster, and more desirable than an ohmmeter. You do not need to disconnect the circuit and voltage source to check for high resistance.

Current Measurement

28. Change your meter controls (range and function) to measure maximum dc current (mA or A). On some meters, you may need to change the location of the meter test leads in their jacks (plug-in sockets). If your meter does not measure 10 A or more, check with your instructor to prevent meter damage. Completed ❑

29. Unlike the ohmmeter and voltmeter, which must be connected in parallel, a conventional ammeter *must* be connected in series with the circuit. Connect your ammeter in series with the circuit as shown in **Figure 3.** Break (disconnect) the circuit at the positive of the battery and insert your meter between the two connections. Completed ❑

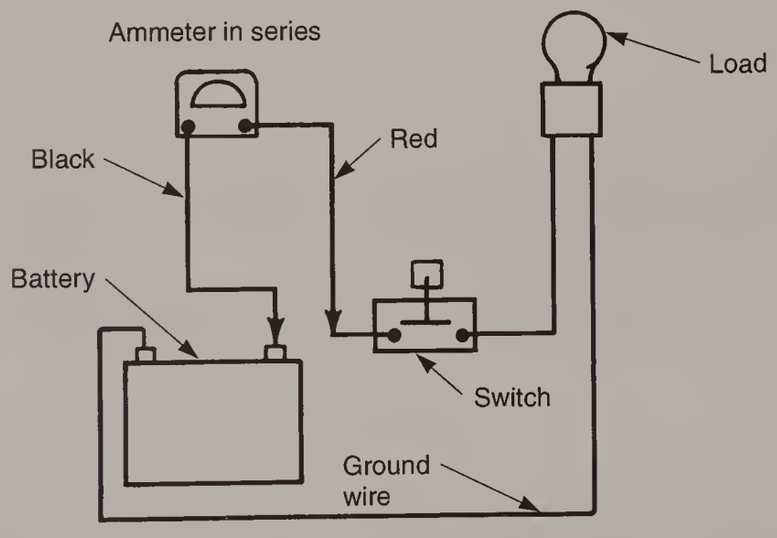


Figure 3. Check that your ammeter is in series and that negative and positive connections are not reversed.

Caution!
Never connect an ammeter in parallel with a circuit as it could damage the meter. Also, a short circuit may be produced, causing an electrical fire.

30. Before turning on the power, double-check your meter connections and settings. If they are okay, turn on the switch and measure the current in your circuit. Completed ❑

31. Record the meter readings for the open and closed switch positions. Completed ❑

Switch Settings	Switch Open	Switch Closed
Meter amps reading		

From these extremes (infinite resistance with switch open and normal resistance with only resistance of the lightbulb in the circuit), you can easily see the relationship between current and resistance. A high resistance will lower current. A lowered resistance will increase current.

You will use this principle when using an ammeter. You will measure the actual current flowing in a circuit and compare it to specifications. If the tested circuit current is high, then the circuit resistance is low (short, faulty resistor, defective electric motor, etc.) and vice versa. As a technician, you can then diagnose which component or connection is defective.

32. Clean your work area and return all tools to their proper storage location. Completed ❑

33. Ask your instructor to sign this job.

Instructor's Signature _____

Job 3

Name: _____

Date: _____

Instructor: _____

Score: _____

Using Scan Tools

Objective: After completing this job, you will be able use a scan tool to retrieve trouble codes and read datastream information from a computer-controlled vehicle system.

Tools and Equipment: You will need a scan tool and related harness adapters, a car or light truck, and the appropriate service manual.

Instructions: After getting your instructor's approval, use the shop's scan tool to analyze the operation of the vehicle's computerized engine control system. You should have studied Chapter 21 of your textbook before performing this job.

Scan Tools

1. Examine your test vehicle and fill in the following service information. If necessary, use a service manual.

   Make: _____

   Model: _____

   Year: _____

   VIN: _____

   Engine size: _____

   Transmission type: _____

Late-model vehicles use one of two on-board diagnostic systems—OBD I or OBD II. OBD I was used on all production vehicles until 1994. In 1994, manufacturers began phasing in OBD II systems. Since 1996, all vehicles have been equipped with OBD II systems. Completed ❑

2. What type of on-board diagnostic system does your test vehicle have? (Check the service manual.) Completed ❑

3. Check out an appropriate scan tool and take it to the vehicle. It will come with a variety of harness adapters. Completed ❑

4. What is the name of the scan tool you will be using for this job? _____

   _____ Completed ❑

5. Locate the vehicle's data link connector (DLC). If the vehicle was manufactured before 1996, the DLC may be located in either the passenger compartment or the engine compartment. If the vehicle was manufactured in 1996 or later, the DLC is located under the dash in the passenger compartment. You may need to consult the service manual to locate the data link connector. Completed ❑

6. Where is the vehicle's data link connector located? _____ Completed ❑

7. Look at the data link connector and if necessary find a harness adapter that will connect to the DLC. OBD II vehicles use a standardized 16-pin connector and do not require an adapter. OBD I vehicles use one of a variety of connectors, depending on the manufacturer. Consult the scan tool user's manual or the service manual for assistance. Completed ❑

8. If necessary connect the adapter to the scan tool harness as shown in **Figure 1.** You may need to connect a power adapter cord to the scan tool. The cord will have a single plug on one end with a cigarette lighter adapter on the other. Most OBD II vehicles will power the scan tool directly through the DLC. How does your scan tool receive power?

   _____

   _____ Completed ❑

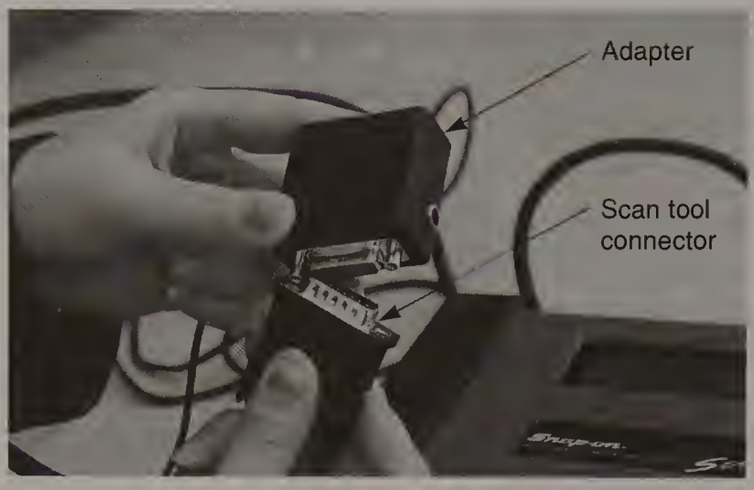


Figure 1. An adapter is sometimes needed between the scan tool cable and the vehicle's data link connector. As OBD II vehicles become more common, these adapters will be needed less.

Scan Tool Program Cartridges

Many scan tools come equipped with several removable program cartridges that contain specific information about the vehicle to be scanned. Most scan tools use one program cartridge at a time. Some scan tools can access two cartridges at the same time. This permits the use of a troubleshooting cartridge.

9. Look in the scan tool manual. How many cartridges can the scan tool access? _____ Completed ❑

10. Carefully install the cartridges for the vehicle to be scanned. Slide the cartridge straight into the tool to prevent damage. Completed ❑

11. What is the title of the scan tool cartridge(s)? _____ Completed ❑

Most scan tools have an LCD screen that can display two or more items. Scan tools also have a keypad or buttons that allow the user to enter vehicle information and commands. See **Figure 2.** Some scan tools have a rotary knob, which is used to move the screen information up and down.

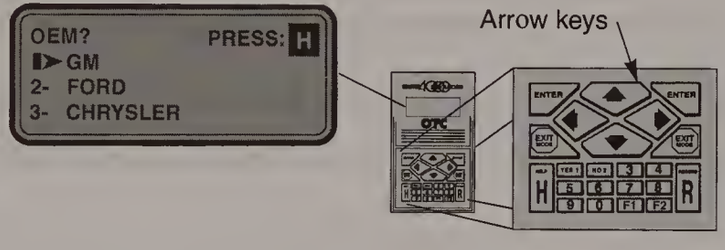


Figure 2. Controls on a scan tool will vary by manufacturer. This scan tool uses a keypad and arrow keys for inputting requested information about the vehicle and desired tests. (OTC)

12. What type of controls does the scan tool have? _____

_____

_____

_____ Completed ❑

Connecting the Scan Tool to the Vehicle

13. After setting up the scan tool, you are ready to connect it to the vehicle. The ignition switch should be *off.* As shown in **Figure 3,** connect the DLC harness first; then connect the power adapter, if used. Do *not* force the connector on the DLC. If the DLC harness does not attach easily, check the pins and the adapter. Make sure you are using the correct adapter. Completed ❑

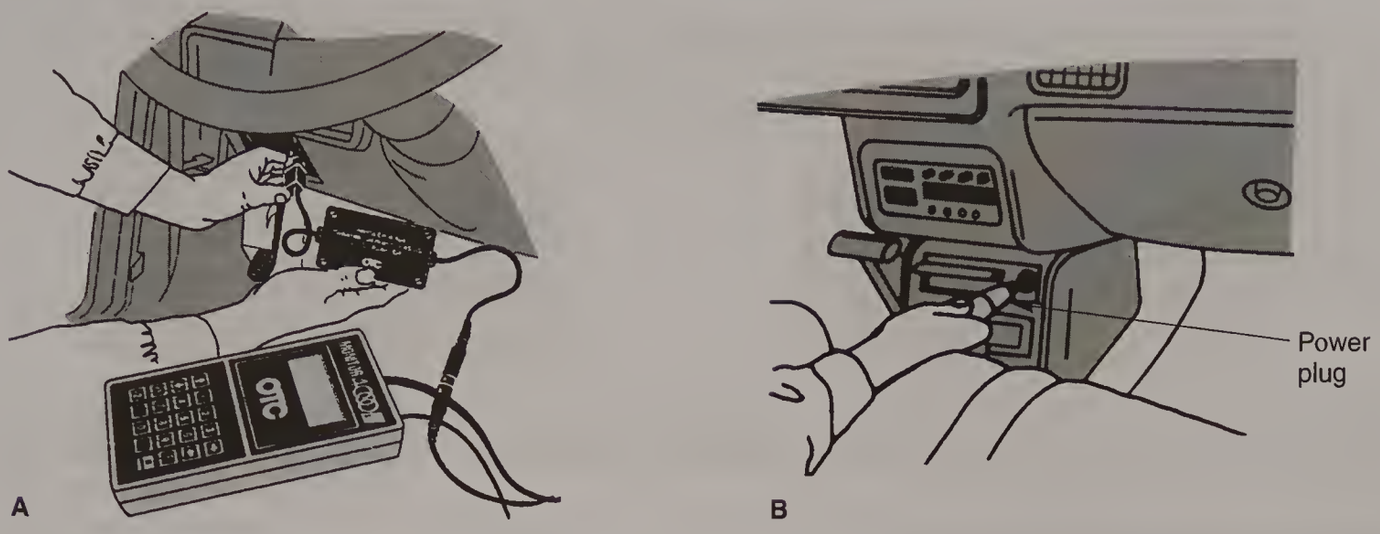


Figure 3. A—Connect the scan tool cable to the data link connector. Make sure the pins match up; do not force them together. B—Scan tools can be powered by a cigarette lighter plug or they can be directly powered by the DLC.

14. After the necessary connections are made, the scan tool display should light. The scan tool will perform a short power-on self-test; then the display will show some information. What information does the scan tool display show?

_____

_____

_____ Completed ❑

Before the scan tool can communicate with the vehicle's computer(s), you must enter some information about the vehicle. Most scan tools will ask you to enter certain numbers and letters from the vehicle identification number (VIN). Others will ask you for the vehicle make, model, year, and engine type.

15. What information did you enter into the scan tool? If VIN information was entered into the scan tool, which numbers and letters did you enter?

_____

_____

_____ Completed ❑

16. What does your scan tool prompt you to do next? _____

_____

_____ Completed ❑

17. If you entered the vehicle information correctly, you will see a menu screen. List the information choices displayed on the menu screen. You may need to scroll down to see all the choices.

_____

_____

_____

_____ Completed ❑

Scan

Accessing trouble codes with the key on and the engine off is often the first step a technician takes when diagnosing a computer system problem. The technician usually looks for codes because the vehicle's malfunction indicator light was on. In some cases, however, the MIL does not light all the time.

18. To perform a scan, turn the ignition key to the run position, but do not crank the engine. Command the scan tool to retrieve stored trouble codes, **Figure 4.** If needed, disconnect a sensor wire and operate the engine to produce a fault in the system before performing this test. Completed ❑

Figure 4. This is an example of what you might see on the display of a scan tool. A—The scan tool will give you the trouble code numbers. B—If you request information on the stored trouble codes, the tool will explain what each code means. (OTC)

19. What trouble code number(s) are given? _____

_____ Completed ❑

20. Using the scan tool or a service manual, explain what the trouble code number(s) indicate.

_____

_____

_____ Completed ❑

Scan

21. To perform a scan, start and warm the engine to full operating temperature to bring the computer system into the closed loop operating mode. Completed ❑

22. Trigger the scan tool to read trouble codes. You may disconnect another sensor or an actuator to produce another trouble code. Completed ❑

23. What trouble codes were given? _____

_____

_____ Completed ❑

24. Scanning the computer system while the engine runs allows you to examine the datastream entering and leaving the computer. When a code is not stored, this is the next place to look for a problem. Select the datastream setting on the scan tool and look over the datastream values for each device. Completed ❑

25. In the spaces provided below, list the datastream values displayed by your scan tool. Your scan tool may not display all the values listed.

Oxygen sensor (O_2S): _____ Mass airflow (MAF) sensor: _____

Throttle position sensor (TPS): _____ Open/Closed loop: _____

Intake air temperature (IAT) sensor: _____ Injector pulse: _____

Coolant temperature sensor (CTS): _____ Idle air control (IAC) solenoid: _____

Vehicle speed sensor (VSS): _____ Torque converter clutch (TCC): _____

Engine RPM: _____ PROM or Program ID number: _____

Manifold absolute pressure (MAP) sensor: _____ Completed ❑

26. Clean your work area and return all equipment to their proper storage locations. Completed ❑

27. Ask your instructor to sign this job.

Instructor's Signature _____

Job 4

Name: _____

Date: _____

Instructor: _____

Score: _____

Computer System Service

Objective: Given the needed tools and equipment, you will be able to test and perform diagnostic operations on a computer-controlled vehicle system.

Tools and Equipment: You will need a basic set of hand tools, a thermometer, a multimeter, a heat gun, a scan tool, and a car or light truck.

Introduction: Computers are now used to monitor and control all major systems of a modern vehicle, including the engine, transmission, suspension, anti-lock brakes, air conditioning, air bags, and even the seat and steering column presets. This makes it critical for today's technician to be well versed in using scan tools and repairing computer troubles. You should have studied Chapters 11, 21, and 22 of your textbook before starting this job.

Service Manual Information

1. Record the vehicle information below. Using a service manual, look up and read the service information on the computer system for your test vehicle. Completed ❑

   Make: _____ VIN: _____

   Model: _____ Engine size: _____

   Year: _____ Transmission type: _____

2. Look in the service manual. How many computers does this vehicle use? _____ Completed ❑

3. What are the names in the service manual of the computers that control the following systems? If the vehicle's system is not computer-controlled or the vehicle is not equipped with a particular system, write the word *none* in the blank.

   Engine: _____ Air conditioning/heating: _____

   Transmission: _____ Air bags: _____

   Anti-lock brakes: _____ Cruise control: _____

   Traction control: _____ Anti-theft system: _____

   Suspension: _____ Other: _____

   Steering: _____ Completed ❑

As discussed in Job 8, there are two types of on-board diagnostic systems, OBD I and OBD II. OBD I was used on almost all production vehicles until 1996. Beginning in 1996, vehicles were required to be equipped with the OBD II diagnostic system.

4. Which on-board diagnostic system does the test vehicle have? _____ Completed ❑

Computer System Diagnostics

After connecting the scan tool and entering the necessary vehicle information, retrieve any trouble codes that are stored. If there are any trouble codes stored in memory, write them down. Then, if available, go to the code history to determine which codes have occurred the most often. This may give you an indication of where the problem lies. You or your instructor may want to unplug a sensor to set a code.

5. List all stored codes and the number of times each was set. _____

_____

_____

_____

_____

_____ Completed ❑

In some cases, you can access vehicle computer systems without a scan tool. Depending on the manufacturer, you can do this by grounding two or more pins on the DLC, turning the key on and off in a certain sequence, or pressing certain buttons on the electronic dash control. However, an OBD II computer can only be accessed using a scan tool.

6. If you were *not* going to use a scan tool, how could you pull up trouble codes on the test vehicle? If the vehicle is OBD II compliant, write *OBD II compliant; access codes using scan tool only.*

_____

_____

_____ Completed ❑

7. Clear the codes and test drive the vehicle. See if any codes reset. If one or more codes reset, they are considered "hard failures." Codes that do not reset are considered "soft failures." Completed ❑

8. List all codes that reset in memory.

_____

_____

_____

_____ Completed ❑

If no codes were present or reset, the problem is most likely intermittent or is not caused by the computer system. You may want to try performing a snapshot to locate the problem. When diagnosing any stored codes, start with the lowest number code and work up. Often, you can eliminate one or more of the higher number codes by starting with the low number codes first.

Visual Inspection and Wiggle Test

9. Look over the engine compartment. Check for disconnected sensors, damaged actuators, and other obvious problems. Completed ❑

10. Did you find any problems? _____

Explain: _____

_____

_____ Completed ❑

11. Do a wiggle test. This is done by wiggling wires to sensors and actuators while scanning for trouble codes. The wiggle test might help you find an intermittent problem. Completed ❑

Warning!
If you perform this test while the engine is running, stay clear of belts and pulleys. If you cannot reach a sensor or other device safely, do not try. Be careful when wiggle testing oxygen sensors, as the exhaust manifold will be extremely hot.

12. Did you find any other problems during the wiggle test? _____

Explain: _____

_____

_____ Completed ❑

Switch Tests

13. If possible, do a switch self test. Follow scan tool instructions to turn each switch on and off. The scan tool will then tell you if each switch is working properly.

    Can you do a switch test on this vehicle? _____

    If so, summarize the results of the test. _____

    _____

    _____

    _____

    _____ Completed ❑

14. Test at least three switch devices. Candidates for switch tests include the brake pedal, air conditioning system, cruise control, and transmission shift lever. Make sure you put the parking brake on and step on the brake pedal when doing the transmission shift test. List the device(s) tested and your test results.

    _____

    _____

    _____ Completed ❑

Sensor Pinpoint Tests

After you have retrieved trouble codes, you must do pinpoint tests to find the exact source of the trouble. A trouble code simply indicates which circuit might be at fault.

15. Using the procedures outlined in the service manual, find and remove the engine coolant temperature sensor. Completed ❑

16. To simulate a test of the sensor, use your heat gun to change the sensor's temperature while measuring its internal resistance with your ohmmeter, **Figure 1.** Concentrate the heat on the sensor tip, *not* the plastic plug. Take resistance readings at the following temperatures and record them in the chart. Completed ❑

Temperature	80°F	100°F	120°F	140°F	160°F
Sensor Resistance					

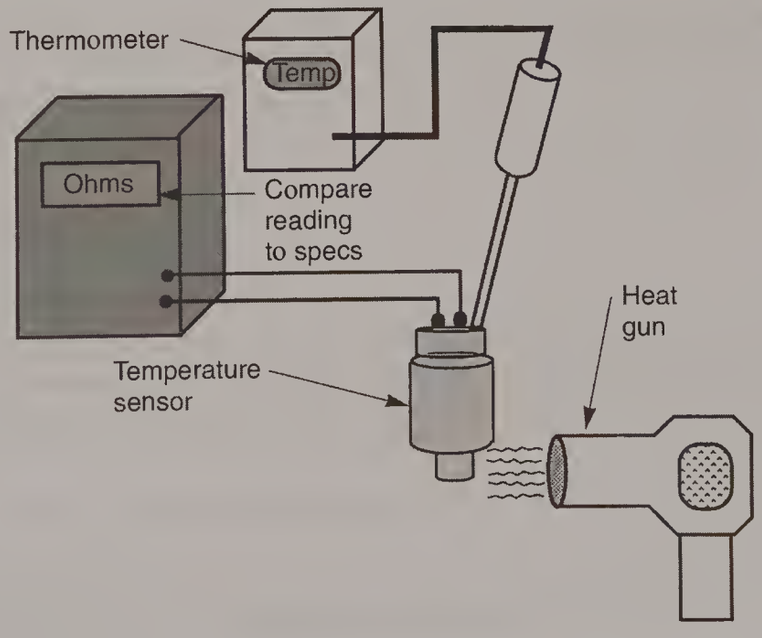


Figure 1. An ohmmeter can be used to measure resistance while heating the sensor with a heat gun.

17. Does your service manual give resistance specifications for the coolant temperature sensor? If so, how do your readings compare to them? _____

_____

_____

_____ Completed ❑

Actuator Tests

18. Perform an actuator self-test. Use the scan tool instructions to "fire" vehicle actuators. The scan tool will signal the vehicle's computer to fire the injectors, idle solenoid, and other actuators. You can then listen to determine if they are working properly. Completed ❑

19. Explain the results of your actuator test. _____

_____

_____

_____

_____ Completed ❑

20. Disconnect the wires to a fuel injector. Using your ohmmeter, measure and record the injector's internal resistance. Compare your readings to service manual specifications. Completed ❑

21. Does the injector resistance indicate a good or bad injector? _____

Explain: _____

_____

_____ Completed ❑

Erasing Computer Trouble Codes

22. Read the service manual instructions for erasing stored trouble codes. Then, use this information to erase any codes in your test vehicle. Trouble codes in most OBD I vehicles can be cleared by disconnecting battery power from the ECM or by using the scan tool. You must use the scan tool to clear codes in an OBD II computer system. Completed ❑

23. How do you erase stored trouble codes on your vehicle? _____

_____

_____

_____

_____

_____ Completed ❑

24. If you disconnected battery power or the ECM at any time, you may need to reset the idle air control solenoid and other devices. In most cases, this can be done by simply driving the vehicle. In a few cases, a special procedure is needed to reset these devices. Check the service manual for any special reset procedures. Completed ❑

25. Clean your work area and return all equipment to the proper storage locations. Completed ❑

26. Ask your instructor to sign this job.

Instructor's Signature _____

Job 5

Fuel Injection Service

Name: _____

Date: _____

Instructor: _____

Score: _____

Objective: Given the needed tools and equipment, you will be able to troubleshoot and repair typical fuel injection system problems.

Tools and Equipment: You will need a basic set of hand tools, fuel pressure gauge, hand vacuum pump, stethoscope, injector noid light, injector balance tester, scan tool, and test vehicle, preferably shop-owned. Read Chapters 16 and 26 before beginning this Job.

Instructions: Fuel injection systems have replaced carburetors on modern cars. This makes it critical that you know how to troubleshoot and repair these systems. Keep in mind that many parts in carburetor systems can be compared to the parts and operating modes of a fuel injection system. Knowledge about one can be transferred to the other when troubleshooting. After getting your instructor's approval, use the following instructions and a service manual to analyze the operation of the vehicle's fuel injection system. Be sure you wear eye protection at all times while performing this job.

Fuel System Inspection

1. Record the vehicle information below. Using a service manual, read the service information on the fuel injection system for your test vehicle.

   Make: _____

   Model: _____

   Year: _____

   VIN: _____

   Engine size: _____

   Transmission type: _____ Completed ❑

2. Begin your fuel injection system service by inspecting for obvious problems. If possible, start the engine. Look for fuel leaks, disconnected wires, leaking vacuum hoses, and similar troubles. Completed ❑

3. Could you find any visible problems with the fuel injection system? _____

   Explain: _____

   _____

   _____

   _____

   _____

   _____ Completed ❑

   Warning!
   Do not smoke in the shop or create sparks or flames.

4. If the fuel pump is operating, you may be able to hear it running. Most fuel pumps used with injection systems are located in or near the fuel tank. Have someone turn the ignition key to the run position (do not crank the engine) while you listen for the electric fuel pump. If the pump is in the fuel tank, you may want to remove the fuel fill cap to better hear the pump. Completed ❑

5. Could you hear the fuel pump running? Completed ❑

6. If the engine runs, use a stethoscope to listen to each injector. Start the engine and place the stethoscope lead near each injector. Each injector should be clicking to indicate that it is opening and closing. The noise from each injector should also be similar. Record your observations in the following chart. Completed ❑

Cylinder Number	1	2	3	4	5	6	7	8
Sound								

7. Did the stethoscope test reveal problems with any of the injectors? _____

   Explain: _____

   _____

   _____

   _____ Completed ❑

Fuel Injector Harness Testing

The fuel injectors receive their power through a feed circuit. This circuit commands the injector to spray fuel into the engine. Occasionally, these circuits become shorted or open. These circuits can be checked by using a noid light, which is a special test light used to check EFI feed circuits. A noid light can also be used to check that the injectors are receiving a "pulse" when diagnosing no-start problems.

8. Disconnect the wiring harness from one injector. Be sure to release the locking mechanism. *Do not* force the harness off. Fit the correct style noid light into the injector harness connector, **Figure 1.** Start the engine and check the light. Completed ❑

Figure 1. Install the noid light into the injector connector.

9. Did the light flash after the engine was started? _____ Completed ❑
10. Reconnect the injector wiring harness. Completed ❑

Checking Fuel Pressure

11. Locate the fuel pressure test fitting on the engine. On multiport fuel injection systems, it is usually on the fuel rail. If the engine is throttle body injected, there may not be a test fitting. You will have to install a fuel pressure gauge in the line itself. Completed ❑

Testing Fuel Injectors

An injector balance tester can measure the amount of fuel flowing through each injector. It can tell you if any of the injectors are clogged or not operating.

12. What kind of injector balance tester are you going to use? _____

_____

_____ Completed ❑

13. Read the owner's manual for the tester. Completed ❑

14. Install the injector balance tester on the engine. How did you do this? _____

_____

_____

_____

_____ Completed ❑

15. With the fuel pressure gauge you used earlier still installed, start the engine and use the injector balance tester to check the volume of fuel leaving each injector, **Figure 2.** Record your test results in the following chart. Completed ❑

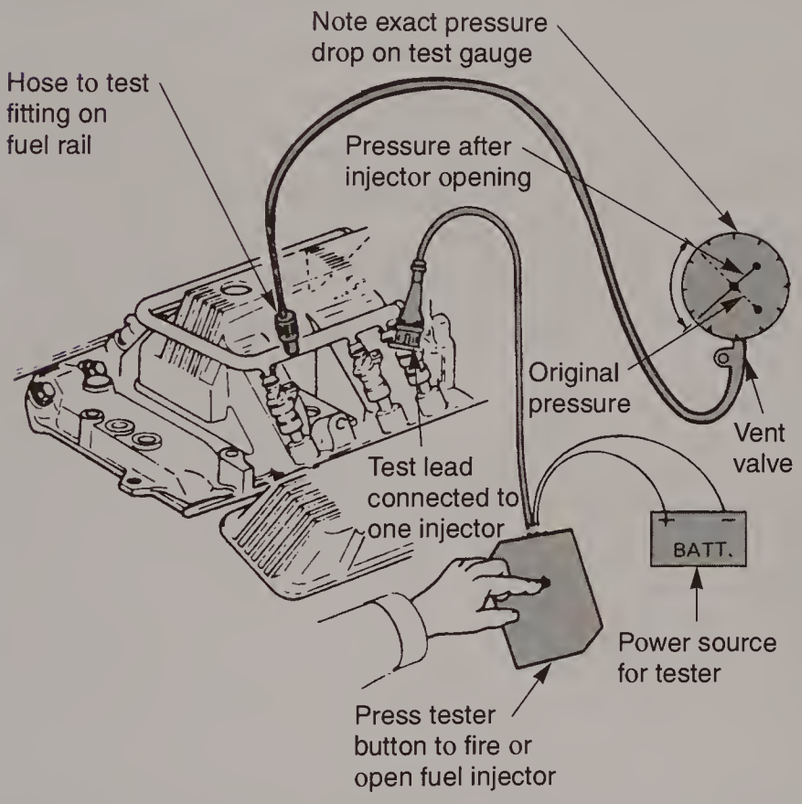


Figure 2. Connect the test harness to each injector. Press the tester button and notice the reading on the fuel pressure gauge.

	Balance Tester Results	Scan Tool Results
Injector 1		
Injector 2		
Injector 3		
Injector 4		
Injector 5		
Injector 6		
Injector 7		
Injector 8		

16. In some cases, you can perform an injector balance test using a scan tool. Read the scan tool user's manual to make sure it can perform this task. Repeat step 30, but this time, use the scan tool to disable each injector. Make sure the scan tool is disabling the injectors and not the ignition system to each cylinder. Completed ❑

17. Did the scan tool test results match those you obtained using the injector balance tester? _____ Completed ❑

Removing Fuel Injectors

18. Remove and reinstall one of the fuel injectors. Describe how this was done. Be aware that injector removal on some vehicles is quite complicated and may take more than one class period to complete. Your instructor may tell you to skip this part of the job.

_____

_____

_____

_____

_____

_____ Completed ❑

19. Remove all test equipment from the engine. Make sure you clean up any spilled fuel and reconnect all vacuum hoses and wiring harnesses. Completed ❑

20. Clean your work area and return all equipment to the proper storage locations. Completed ❑

21. Ask your instructor to sign this job.

Instructor's Signature _____

Job 6

Name: _____

Date: _____

Instructor: _____

Score: _____

Charging and Starting System Testing

Objective: After completing this exercise, you will be able to test the operating condition of a battery, starting system, and charging system using a modern inductive-type load tester.

Tools and Equipment: You will need access to an operating shop vehicle, an inductive-type load tester, a digital multimeter capable of 10 A reading, safety glasses, and the shop area.

Instructions: During this job you will actually test the battery, charging system, and starting system of a running vehicle. You will do this using a load tester. You should perform this job on a shop vehicle as you will be placing high amperage loads on the battery.

Battery Load Test

1. Check out the load tester and move it to the test vehicle. Ask your instructor for added details if needed. Completed ❑
2. Is your load tester an inductive type? _____

   If the load tester is *not* an inductive type, you will have to read the operating instructions for the unit and modify the instructions in this job for your particular tester. Completed ❑
3. Connect the load tester to the battery. If an inductive type is used, connect the two battery leads to the battery posts or side terminals. Clip the amps pickup over the negative battery cable, **Figure 1.** Completed ❑
4. Does your battery have top posts or side terminals? _____ Completed ❑

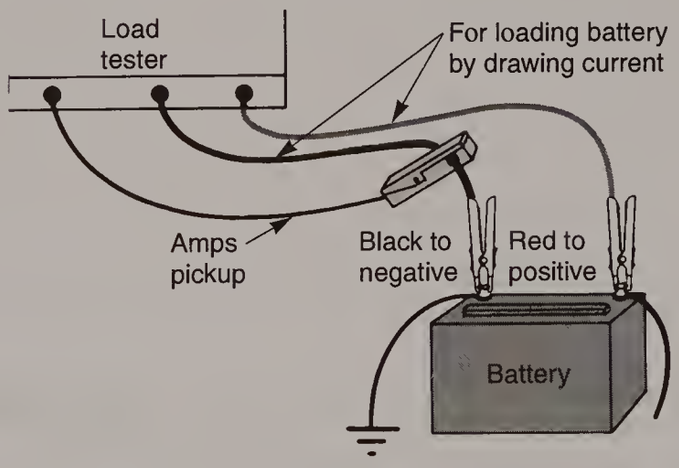


Figure 1. Modern load testers are connected as shown. (Marquette)

5. Determine the rating of the battery you are going to load test. The rating should be printed somewhere on the battery. If you cannot find its rating, ask your instructor for help or refer to the textbook. Completed ❑
6. What rating is given for your battery (cold cranking, amp-hour, or watts)? _____

   _____

   _____ Completed ❑

7. What is the rating of your battery? _____ Completed ❑

8. Using the chart in **Figure 2,** how many amps should be drawn through the battery when load testing?

_____ Completed ❑

Battery ratings			
Cold cranking current	Amp-hour (approx.)	Watts	Load test amps
200	35–40	1800	100 amps
250	41–48	2100	125 amps
300	49–62	2500	150 amps
350	63–70	2900	175 amps
400	71–76	3250	200 amps
450	77–86	3600	225 amps
500	87–92	3900	250 amps
550	93–110	4200	275 amps

Figure 2. This chart lists different battery ratings and calculated current values for load testing. (Marquette)

9. Before load testing, make sure the battery is fully charged. A charged battery should have an open circuit voltage (OCV) of at least 12.4 volts. Completed ❑

10. What is the OCV of your battery? _____ Completed ❑

11. Is your battery fully charged? _____ Completed ❑

12. Turn the load tester control knob until the ammeter reads the correct load test amps determined from the chart in **Figure 2.** Hold the load for 15 seconds. Then, read the voltmeter and turn off the load. Completed ❑

Note!
A good battery should keep voltage at about 9.5 volts or higher during the load test. A bad or discharged battery will let the voltage drop below 9.5 volts.

13. What did your voltmeter read during the load test? _____ Completed ❑

14. Did your battery test good or bad? _____

Explain: _____

_____

_____ Completed ❑

Battery Drain Test

A battery drain test is often performed when diagnosing an unexplained battery discharge and when replacing a discharged battery. All modern vehicles have some current draw (in the milliamps range).

15. To perform the test, set the meter to measure dc amperage. Disconnect a battery cable from the battery and connect the meter in series, **Figure 3.** Completed ❑

16. What is the amperage reading on the meter? _____ Completed ❑

17. If the meter does not read an abnormally high draw, create a draw by opening one of the vehicle's doors. Completed ❑

Caution!
If the meter reads over 10 amps, disconnect the meter immediately and make sure no high amperage circuits are on. Do *not* turn on the vehicle's headlights or other high amperage device to create a draw as it could damage the meter.

18. What is the amperage reading on the meter with one of the vehicle's doors open? _____ Completed ❑

19. Disconnect the meter and reconnect the negative cable to the battery. Completed ❑

Starting Current Draw Test

A load tester can also be used to measure the current draw from the starting motor. For example, if an engine cranks slow, the tester can be used to find out if the starter motor itself is defective.

A good starting motor should draw a specific amount of amps. **Figure 3** lists typical current draw values for starting motors. If during the test, current draw is high or low, it indicates problems with the motor or circuit.

20. How much current should your starting motor draw? Use the chart in **Figure 3.** _____ Completed ❑

Engine Displacement	12-Volt system Max. Current
Most 4–6 Cylinders	125–175 Amps Max.
Under 300 C.I.D.	150–200 Amps Max.
Over 300 C.I.D.	175–250 Amps Max.

Figure 3. Chart shows typical current draw values for different engine sizes. (Marquette)

21. To prevent engine starting, disable the ignition system. This can be done by disconnecting the primary wires feeding current to the coil or coil pack. Completed ❑

22. With the load tester connected properly (as in the first test of the battery with an inductive-type tester), measure starting current draw. Crank the motor for about 10 seconds and note the ammeter reading. The initial readings should be ignored until the current draw stabilizes. Completed ❑

23. What was the ammeter reading while you were cranking the engine? _____ Completed ❑

24. Was your starting current draw within acceptable limits? _____

    Explain: _____

    _____

    _____ Completed ❑

Charging System Output Test

A load tester is also commonly used to test charging system condition. It can be used to load the system while measuring alternator output.

25. If you are using an inductive-type tester, your test connections do not have to be changed. Set the tester controls properly. Completed ❑

26. Turn the ignition key switch to *run*. Note this ammeter reading.

    What did the ammeter read? _____ Completed ❑

27. Start the engine. Adjust the idle speed to the test specifications (about 2000 rpm). Completed ❑

28. Adjust the load control on the tester until the ammeter reads specified current output but *do not* let voltage drop below specifications (about 12 volts). Note (write down) this ammeter reading.

_____ Completed ❑

29. Rotate the load control to off. Evaluate readings. Completed ❑

30. Add your two ammeter readings (steps 26 and 28) to get system output. _____ Completed ❑

31. Look up the specifications for your alternator current output.
Did your system check good or bad? _____

Explain: _____

_____

_____ Completed ❑

If the system tested bad, other tests will be needed to pinpoint the problem. Refer to the text for more information.

32. Clean your work area and return all tools to their proper storage location. Completed ❑

33. Ask for your instructor's signature.

Instructor's Signature _____

Job 7

Name: _____

Date: _____

Instructor: _____

Score: _____

Ignition System Service

Objective: Using the tools and equipment listed below, you will learn to explain the principles and basic service procedures for ignition systems.

Tools and Equipment: For the first part of the job, check out a shop-owned distributor, flat feeler gauge, and standard screwdriver. For the second part of the job, you will also need a 3/8″ drive speed handle, safety glasses, ignition coil, two jumper wires, remote starter switch, spark plug, spark plug wire, a battery or 12 V power supply, ballast resistor, ignition coil, electronic ignition distributor, piece of vacuum hose, fender cover, and dwell meter.

Instructions: This is a very informative learning exercise; so take your time. Follow the job procedures carefully and answer all the job questions. During this job, you will actually build and observe the operation of an ignition system. You will connect the parts of an ignition system with jumper wires at a workbench. Then, by spinning the distributor with a speed handle, you can inspect the firing of a spark plug. You will also learn to adjust pickup coil air gap and set spark plug gaps.

Review of Distributor

This job requires several hours for completion. Unless the length of your class permits, only attempt to finish the first section of the job.

Even though you may never have to work on one, a contact point ignition system is an excellent way for you to better understand modern electronic and computer-controlled ignition systems. Many of the parts (spark plugs, secondary wires, ignition coil, etc.) and operating principles are the same.

1. Check out a distributor and other components listed for part one of the job. Completed ❑

2. Lightly clamp the distributor housing in a vise. See **Figure 1.** The distributor shaft must be free to turn. On some vises, the distributor should be placed to one side of the jaws so the distributor gear will clear. Completed ❑

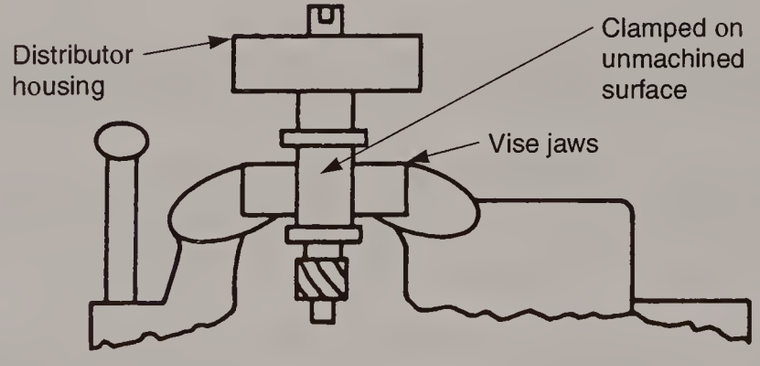


Figure 1. The vise jaws must clamp on the distributor housing, preferably on an unmachined portion of the housing. Vise caps, rags, or small pieces of wood should be used to protect the distributor from damage.

3. Check the distributor for wear. Wiggle the distributor shaft sideways. If the shaft is loose in the housing, the shaft or shaft bushings are worn. Also, check the base plate for looseness. Completed ❑

4. Can you detect any wear in the distributor bushings? _____

   Explain: _____

   _____ Completed ❑

5. Check the condition of the vacuum advance diaphragm. Apply a vacuum to the diaphragm to make sure it does not leak. Also check that it moves the breaker plate properly. Completed ❑
6. Does the vacuum advance diaphragm leak? _____ Completed ❑
7. Does the distributor plate advance? _____ Completed ❑
8. You are ready to gap your pickup coil or points. Turn the distributor shaft until a trigger wheel tooth is aiming at the pickup coil point or the running block is touching one of the cam lobes. See **Figure 2.** Completed ❑

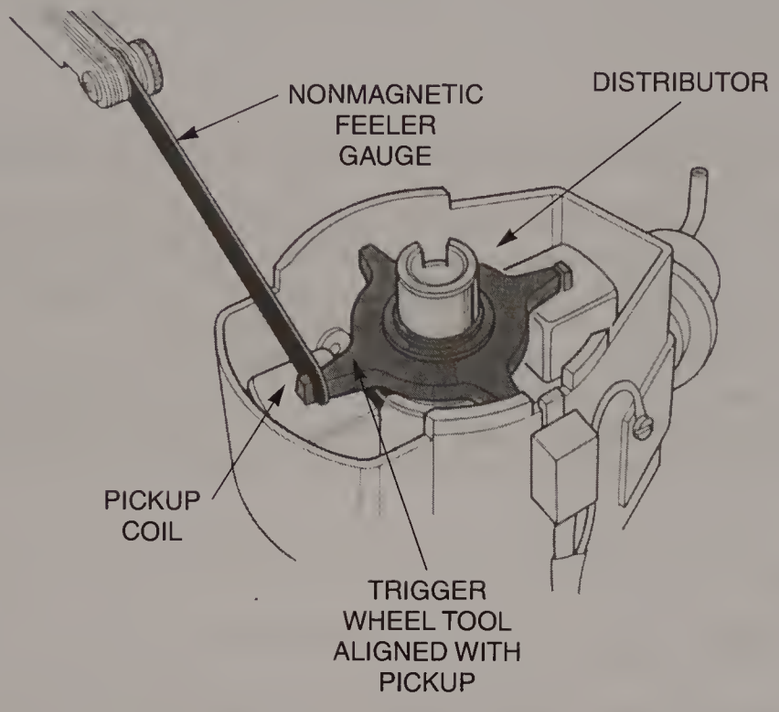


Figure 2. To set the pickup coil or point air gap, turn the distributor shaft until the points are fully open or the trigger wheel tooth is pointing at the pickup coil. Slide the correct thickness feeler gauge between the gap. Open or close the gap until the gauge just touches.

9. After wiping it clean, insert the proper size feeler gauge (around 0.017″ or 0.43 mm) between the pickup coil and trigger wheel tooth or contact points. Shift the pickup coil on its mount, or open or close the points until the feeler gauge just fits between the two. The blade should have a very light drag when pulled out. Completed ❑
10. When the gap is set correctly, tighten the hold-down screws. Double-check the gap because it could change as the screws are tightened. Completed ❑
11. Ask your instructor to check your pickup or point gap and sign this job for credit.

Instructor's Signature _____

Gapping Spark Plugs

12. Check out the rest of the tools and equipment listed at the beginning of the job. Completed ❑
13. Set the spark plug gap. Insert a 0.035″ (0.89 mm) spark plug or wire feeler gauge between the electrodes. The gauge should touch both electrodes in the spark plug. Completed ❑
14. To change the spark plug gap, bend the side electrode up or down. Many feeler gauges have a tool for grasping and bending the plug electrode. There should be a slight drag as the gauge is pulled through the spark plug gap. Completed ❑

Ignition Circuit Wiring

15. Connect the parts of your ignition system using the jumper wires and remote starter switch. **Figure 3** illustrates how the wires and components must be connected. Depending on your distributor, you may or may not need a ballast resistor. Completed ❑

Caution!
When connecting the ignition system components, keep all the parts and wires organized on your workbench to prevent any connections from shorting. Also, do *not* connect the battery or power source until you are ready to test your circuit.

16. Start connecting your wires at the positive battery terminal and work your way through the ignition circuit. This will prevent you from forgetting to connect any component. Do *not* connect to the negative cable. As in **Figure 3,** the spark plug shell, distributor housing, and battery negative must be all *grounded together*. If you fail to ground any of these parts, the ignition system will not work. Completed ❑

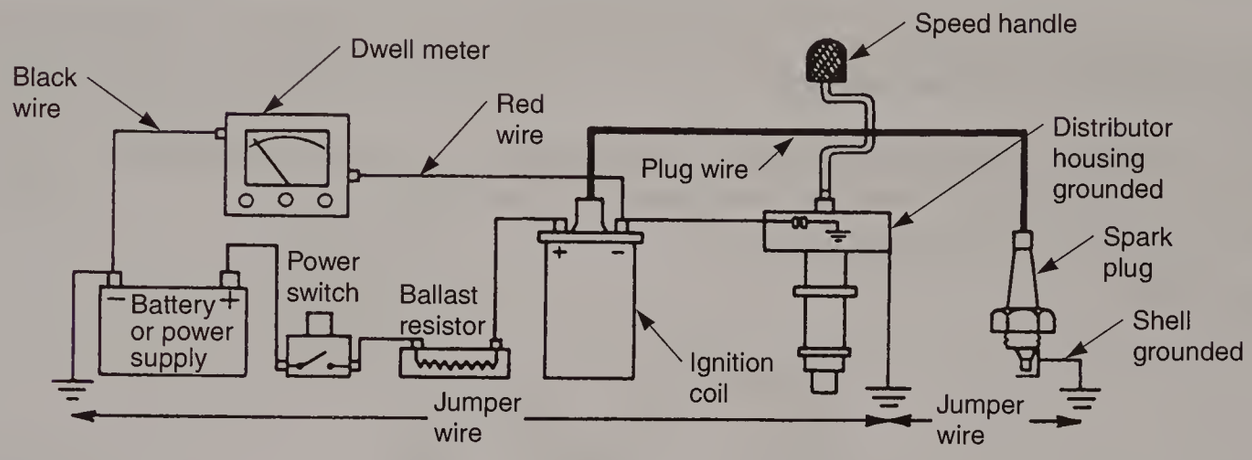


Figure 3. This drawing shows how parts of your ignition system should be connected. Note the jumper wires grounding major parts to the battery's negative terminal.

17. Read steps 15 and 16 again. Double-check all your connections. Make sure none of your "hot wires" are shorted to ground. Completed ❑

Using a Dwell Meter

18. Make sure the dwell meter is connected to the negative side of the coil and to ground. Check that the meter settings (number of cylinders, dwell, etc.) are correct and, if required, calibrate the meter. Completed ❑

19. Ask your instructor to check your circuit before connecting the power source. Completed ❑

20. Connect your ignition system grounds to the negative battery terminal. Use the finger rule to determine the direction of distributor rotation. See **Figure 4.** Completed ❑

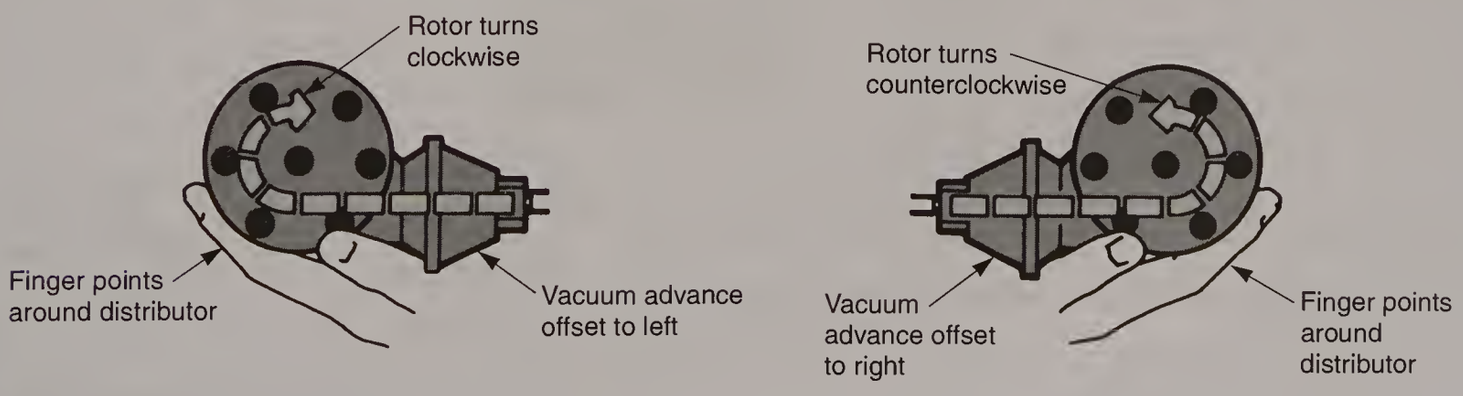


Figure 4. Use the finger rule to determine the direction of rotor rotation. Point around the distributor as shown. This will tell you how the rotor turns without removing the cap and watching the rotor. (Florida Dept. of Voc. Ed.)

21. What is the direction of rotation of your distributor shaft? _____

_____

_____ Completed ❑

22. Gap the distributor pickup coil or points to the setting given in the service manual for the vehicle it came from or approximately 0.020″ (0.51 mm). Completed ❑

23. Force the end of your speed handle into the prepared distributor shaft. Turn the speed handle the correct direction while your partner presses the power switch. This should make the spark plug "fire" and the dwell meter register cam angle. Completed ❑

24. While spinning the distributor, read the dwell meter. It will register dwell for your present point gap setting. What is the dwell meter reading? _____ Completed ❑

25. Ask your instructor to sign this job.

Instructor's Signature _____

Electronic Ignition System Service

26. Check out an electronic ignition system distributor, ignition module (if not attached to the distributor), and ignition coil. Read a service manual that covers the service of the distributor. Completed ❑

27. Remove the distributor cap from the distributor body.

How is this done? _____

_____

_____

_____ Completed ❑

28. Inspect the inside of the cap for signs of cracks, carbon traces, and burning. Can you find any signs of failure? _____ Completed ❑

29. If necessary, remove the ignition coil from the distributor cap. Completed ❑

30. Using an ohmmeter, check the internal resistance of the ignition coil windings. Record your readings below.

Coil Primary Winding Resistance _____

Coil Secondary Winding Resistance _____ Completed ❑

31. Is the coil resistance within specifications? _____ Completed ❑

32. Check the distributor shaft bushings for wear. Try wiggling the top of the shaft sideways while you watch for movement in the distributor body. If the shaft wiggles sideways, the shaft bushings are worn. Completed ❑

33. Explain the condition of the distributor shaft bushings. _____

_____

_____

_____

_____ Completed ❑

34. Remove the distributor shaft. Refer to your service manual if needed. Completed ❑

35. What do you have to do before removing the distributor shaft? _____

_____

_____ Completed ❑

36. Inspect the shaft for signs of wear at the bushing bearing surfaces. Use a micrometer to measure shaft diameter at its most worn point and on an unworn point. Record your readings below.

    Shaft diameter (most worn): _____

    Shaft diameter (unworn): _____ Completed ❑

37. Is the distributor shaft worn beyond specifications? _____

    Explain: _____

    _____ Completed ❑

38. Use a telescoping gauge and micrometer to measure distributor bushing inside diameter. Record your measurements below.

    Lower bushing inside diameter: _____

    Upper bushing inside diameter: _____ Completed ❑

39. Use your ohmmeter to check the condition of the pickup coil. See **Figure 5.** Wiggle the pickup coil wires while measuring resistance. Sometimes the pickup coil wires can break internally and cause a resistance fluctuation. Record your readings below.

    Pickup coil resistance: _____ Completed ❑

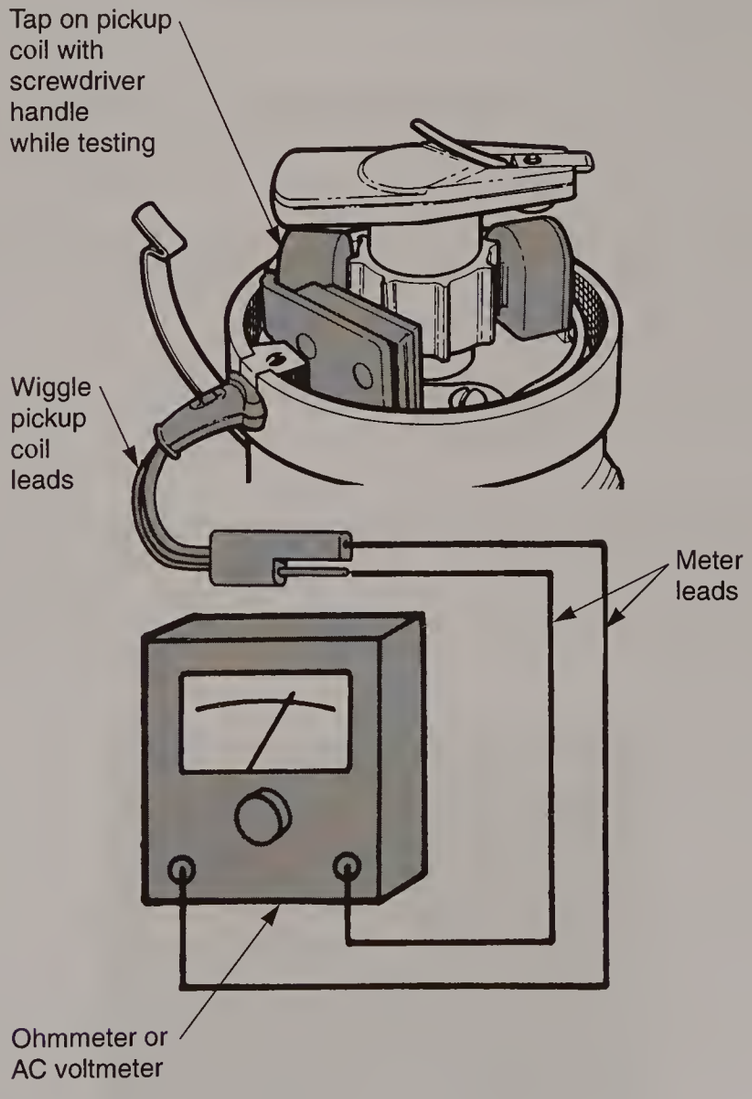


Figure 5. Using an ohmmeter to check the pickup coil.

40. Remove the ignition module, if attached. Completed ❑

41. How many wires are connected to the module? _____ Completed ❑

42. Use a high-impedance ohmmeter to measure the resistance across the terminals of the ignition module. Record your readings. _____

_____ Completed ❑

43. How does the service manual say to test an ignition module? _____

_____

_____

_____

_____

_____ Completed ❑

44. Reinstall the module. In some cases, you may need to wipe a thin layer of dielectric grease across the bottom of the unit. This helps keep it from overheating. Install the module and tighten each fastener equally. Completed ❑

45. Reassemble the distributor following service manual instructions. Completed ❑

46. Clean your work area and return all tools to the proper storage locations. Completed ❑

47. Ask your instructor to sign this job.

Instructor's Signature _____

Job 8

Name: _____

Date: _____

Instructor: _____

Score: _____

Using Vehicle Analyzers

Objective: After completing this job, you will be able to utilize a vehicle analyzer when trying to find electrical-electronic related performance problems.

Tools and Equipment: You will need access to an analyzer, an ignition system training unit or running vehicle, exhaust vent system, set of basic hand tools, fender covers, wire feeler gauge, and access to the auto shop.

Instructions: During the job, you will connect an analyzer to an engine or ignition trainer. Then, by following the instructions, you will regap spark plugs, disconnect plug wires, and simulate other common causes of engine performance problems. This will let you see how the analyzer can detect and show engine performance problems. Study textbook Chapter 29 before doing this job.

Analyzer Type

1. Check out an analyzer. Ask your instructor whether an ignition system training unit or an engine will be used during the job. Completed ❑
2. What is the brand name of the analyzer? _____ Completed ❑
3. Give the following information for the vehicle or ignition system training unit to be tested. Ask your instructor for this data if you are using an ignition training unit. Completed ❑

Make: _____ VIN: _____

Model: _____ Engine size: _____

Year: _____ Transmission type: _____

Note!
Operating instructions for analyzers vary. The instructions in this job are general, so you will have to modify them to meet your specific type of analyzer. Have the operating instructions for the analyzer handy and study them before beginning the job.

Figure 1 shows one make and model of analyzer. Although the controls may look different than those you are using, all controls are similar.

Figure 1. Analyzers contain several test instruments in one housing.

4. What external differences can you see in *your* analyzer and the one in **Figure 1.**

_____

_____

_____

_____

_____

_____ Completed ❑

5. List the testing devices mounted on your analyzer.

_____ _____

_____ _____

_____ _____

_____ _____

_____ Completed ❑

As detailed in the text, the oscilloscope is the "heart" of an analyzer. It will measure voltages very accurately. Study your scope screen. Note the values given on the screen.

6. What values are given on the left vertical scale? _____ Completed ❑
7. What values are given on the right vertical scale? _____ Completed ❑
8. What values are given along the bottom horizontal scale? _____ Completed ❑

Connecting the Analyzer

9. Connect the analyzer to the vehicle or the ignition training unit. Follow the operating instructions for your particular analyzer. Completed ❑
10. Does your ignition system have the coil mounted inside the distributor? _____ Completed ❑
11. Where did you connect the timing light pickup? _____

_____

_____ Completed ❑
12. How did you connect the ignition coil pickup? _____

_____

_____ Completed ❑
13. Where did you connect the analyzer ground? _____

_____

_____ Completed ❑
14. Does the analyzer have an exhaust gas probe? _____ Completed ❑

Caution!
Make sure none of the analyzer leads are near the engine fan or hot engine exhaust manifolds. The leads are very expensive and can be easily damaged.

15. Are your analyzer test leads routed properly? _____ Completed ❑

Secondary Scope Patterns

As a review, study the parts of the waveform, in **Figure 2.**

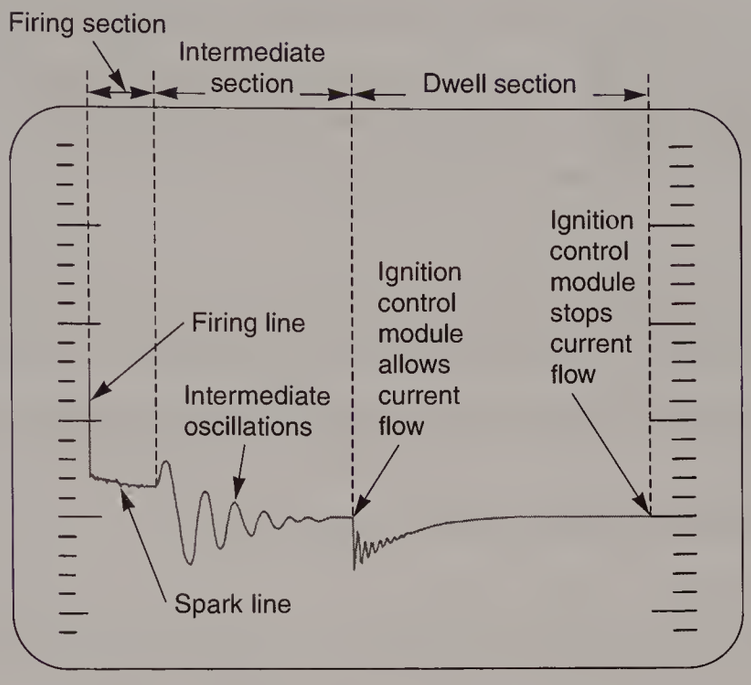


Figure 2. A secondary waveform for one cylinder. The firing line is the voltage needed to fire the spark plug. The spark line is the voltage needed to maintain the spark across the plug gap. Intermediate oscillations show the coil and condenser action. Dwell is the amount of time primary current flows through the ignition coil.

16. Set your controls to check secondary voltage, superimposed. Completed ❑
17. Turn on the ignition system training aid or start the engine. If needed, connect a vent hose to the exhaust. Completed ❑
18. Inspect the scope pattern. Since all of the cylinder patterns are stacked on top of each other, this pattern can quickly tell you if there are problems in any cylinder. Completed ❑

Open Plug Wire

19. Shut off the trainer or the engine. Disconnect one spark plug wire, restart the engine or trainer, and recheck the pattern. Completed ❑

Caution!
Do *not* let the engine run for more than a few seconds or the catalytic converter could be contaminated.

20. What differences did you notice in the secondary superimposed? _____

_____

_____

_____ Completed ❑

21. To find which cylinder is bad, switch to parade. This compares all the cylinders side-by-side. Completed ❑
22. Does your parade pattern reflect the disconnected spark plug wire? _____

Explain: _____

_____ Completed ❑

23. Shut off the trainer or the engine. Completed ❑

Fouled Spark Plug

Caution!
If the engine is equipped with aluminum heads, allow the engine to cool before removing the spark plug.

24. Remove one spark plug from the engine or the trainer. Close its gap until the electrodes are almost touching. Reinstall the plug and reconnect all plug wires. Recheck the parade pattern. Completed ❑

25. Could you detect the closed spark plug gap on the parade pattern? _____

Explain: _____

_____

_____ Completed ❑

Note!
A closed spark plug gap simulates an oil or carbon fouled spark plug. Less voltage would be needed to fire the plug.

26. How did the scope show that less voltage was needed with the closed gap?

_____

_____

_____

_____ Completed ❑

27. Remove and gap the spark plug properly. Completed ❑

Other Analyzer Tests

Today's vehicle analyzers can perform a wide range of tests. They can analyze combustion efficiency, theoretical cylinder compression, charging system condition, starting system condition, trouble codes, computer datastream values, and many other functions.

If possible, use your vehicle analyzer to check the theoretical compression pressure in each engine cylinder. This can be done without removing the spark plugs. The ignition system is disabled and the engine is cranked over. The analyzer can then monitor starter current draw during each revolution of the crankshaft. If a cylinder has low compression, lower current draw will be present on that cylinder's compression stroke.

28. Using the specific instructions for your analyzer, connect the unit to a vehicle and check engine compression. Completed ❑

29. Did the engine pass its theoretical compression test? _____

Explain: _____

_____

_____

_____ Completed ❑

30. If possible, print out the results of your engine analysis and turn it in with this job. Completed ❑

31. Clean your work area and return all tools to the proper storage location. Completed ❑

32. Ask your instructor to sign this job.

Instructor's Signature _____

Job 9

Name: _____

Date: _____

Instructor: _____

Score: _____

Anti-Lock Brake System Service

Objective: Given the proper tools and equipment, you will learn to service an anti-lock brake system.

Tools and Equipment: You will need an appropriate scan tool, a hand-held scope, miscellaneous hand tools, a floor jack, and jack stands.

Instructions: Ask your instructor whether you are to service a customer's vehicle or a shop-owned vehicle. You should have studied Chapters 20 and 28 in your text before starting this job.

ABS System Service

1. Make a visual inspection of all the major parts of the anti-lock brake system. Look for obvious problems that could affect braking action. In addition to checking for conventional troubles, look for the following:
   - ABS indicator light *on.*
   - Brake fluid leaks, especially at the modulator seals, gaskets, and lines.
   - Tires that will not rotate freely.
   - Loose or worn wheel bearings, which could affect wheel speed sensor operation.
   - Badly worn tires or tires of unequal size.
   - Damaged or improperly mounted speed sensors and trigger wheels.

   Completed ❑

2. Did you observe any problems during your visual inspection? _____

   Explain: _____

   _____

   Completed ❑

3. Check out an appropriate scan tool and take it to the vehicle. Completed ❑

4. Connect the scan tool to the vehicle as recommended by the manufacturer. Completed ❑

   Note!
   Make sure you connect the scan tool to the proper diagnostic connector. In most cases, the scan tool will connect to the same DLC used to retrieve engine and power train trouble codes. However, some systems will use different connectors. For example, the diagnostic connector for the ABS on some vehicles is located in the trunk. If in doubt about connector locations, refer to the service manual.

5. Following the instructions provided with the scan tool, check for trouble codes. Completed ❑

6. Were trouble codes present in the system? _____

   If so, list them. _____

   _____

   _____

   _____

   Completed ❑

7. Disconnect the right front wheel speed sensor and recheck the system for trouble codes. Completed ❑

8. Does the scan tool show a problem with the right front speed sensor circuit after the sensor has been disconnected? _____

   Explain _____

   _____

   Completed ❑

Some scan tools can be used to perform advanced tests. This will let you verify that every part is functioning properly. For example, the scan tool can be used to manually control motors, relays, solenoids, and other ABS parts, as well as to check modulator operation. You can also use the scan tool to obtain system datastream values (voltage, current, resistance).

9. Does your scan tool control allow you to make advanced ABS tests? _____
   Explain. _____
   _____
   _____
   _____ Completed ❑
10. If your scan tool indicates a malfunction, further tests, known as pinpoint tests, may be needed. Refer to an appropriate service manual for pinpoint testing procedures for ABS components. Completed ❑
11. Were there any problems indicated by the scan tool readings? _____
    If so, which components will require further tests? _____
    _____
    _____ Completed ❑

ABS Speed Sensor Service

Note!
Before beginning this section, reconnect the wiring to the sensor you disconnected in step 7. Use this sensor when performing the following steps.

12. If scan tool tests point to a speed sensor problem, make sure the affected sensor is mounted securely and that all wire connectors are tight. Completed ❑
13. Check for chipped or broken trigger wheel teeth. Road debris and improper repair methods can damage the trigger wheel. Completed ❑
14. Do the trigger wheel teeth appear to be in good shape? _____
    Explain. _____
    _____
    _____ Completed ❑
15. If necessary, use a nonmetallic feeler gauge to check the air gap between the speed sensor and its trigger wheel. Completed ❑
16. Does the speed sensor air gap require adjustment on the vehicle you are servicing? _____ If so, what is the air gap specification? _____ Completed ❑
17. Unplug the wiring to the speed sensor and connect the hand-held scope to the sensor's output leads. Completed ❑
18. Spin the corresponding wheel by hand and observe the waveform displayed on the scope screen. Completed ❑
19. Compare the waveform produced by the sensor to a known good waveform, **Figure 1.** Completed ❑

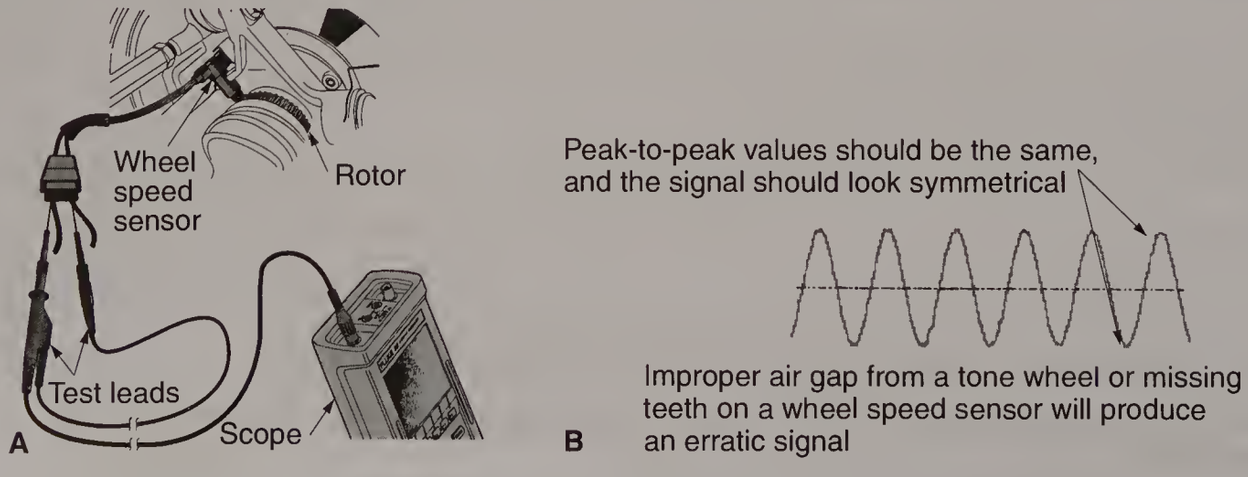


Figure 1. A—Typical test connections for checking a wheel speed sensor waveform. B—Waveform produced by a properly functioning sensor. (Fluke)

20. Does the speed sensor produce a good waveform? _____

Explain. _____

_____ Completed ❑

Note!
If a pinpoint test of a wheel speed sensor shows no problem but the scan tool indicates a problem, check the wiring between the sensor and the anti-lock control module. If the wiring is not faulty, suspect the control module.

21. If the sensor is bad, obtain the proper replacement. Completed ❑

22. To remove the sensor, remove the small bolts used to hold the sensor to the suspension knuckle. Also remove any clips used to secure the sensor wire to the body to prevent wiring damage. Completed ❑

23. Install the new sensor in the reverse order of removal. Make sure all bolts and clips are in place. Completed ❑

24. After installing the new wheel speed sensor, adjust its air gap if needed using a brass or plastic feeler gauge. Completed ❑

Caution!
When working on vehicles with anti-lock brakes, be careful not to damage the wheel speed sensor trigger wheels. When removing calipers, axles, and related parts, it is easy to hit and chip one or more of the small teeth on the trigger wheel. When the vehicle is driven again, this would activate a trouble code and require trigger wheel replacement.

ABS Modulator Check

Most ABS modulator problems will show up when scanning. However, some automakers specify a procedure for checking the modulator. The following is a general procedure for checking the operation of the modulator, brake tubing, brake hoses, solenoids, relays, ECM, and other major parts. Refer to the service manual and scan tool manual for specific test instructions.

25. Place the vehicle on jack stands so all four tires are an equal distance from the ground. Completed ❑

26. Make sure the parking brake has been released. Completed ❑

27. Rotate each wheel by hand. Make sure none of the wheels is dragging. A dragging wheel indicates that the system might not be releasing hydraulic pressure normally. Brake drag can also be caused by a frozen wheel cylinder, a restricted brake line or hose, and similar problems. Completed ❑

28. Do the wheels rotate freely? _____

Explain _____

_____ Completed ❑

29. Connect a jumper wire to the correct terminals on the vehicle's diagnostic connector or use the scan tool to energize the modulator to apply hydraulic pressure to one of the wheels. Completed ❑

30. Press down and hold the brake pedal while you have a helper make sure that the wheel will not rotate. Completed ❑

31. Using service manual instructions, energize the modulator to dump pressure to the wheel. Make sure the modulator relieves pressure from the wheel cylinder so the tire will rotate freely. Completed ❑

32. Repeat steps 29–31 on the other wheels. Completed ❑

ABS Modulator Service

If the ABS modulator is faulty, a new or factory-rebuilt unit is generally installed. Modulators are very complex and time consuming to rebuild.

Warning!
Before servicing the modulator or any other hydraulic component in an ABS system, be sure to depressurize the system according to the vehicle manufacturer's instructions.

33. To remove an ABS modulator, disconnect all wires between the vehicle and unit. Completed ❑

34. Use a tubing wrench to loosen the brake lines going to the modulator. Completed ❑

35. Remove the bolts that hold the modulator on its brackets and then lift the unit out of the engine compartment. Completed ❑

36. If you are installing a new or rebuilt unit, transfer any necessary parts from the old unit to the new one. These parts might include the combination valve, reservoir, master cylinder (integral units), and brackets. Completed ❑

37. Were there any parts that had to be transferred from the old modulator to the new unit? _____

    Explain: _____

    _____

    _____ Completed ❑

38. Position the new unit on the vehicle and install the necessary bolts. Completed ❑

39. Install the brake lines and tighten them using a tubing wrench. Completed ❑

ABS Test Drive

40. After servicing the ABS system, start the vehicle and make sure the ABS indicator light goes off after the specified amount of time (approximately 5 seconds). Completed ❑

41. Shut the vehicle off and use a scan tool to make a final check for trouble codes. Completed ❑

42. Were any codes found? _____

    Explain. _____

    _____ Completed ❑

43. Test-drive the vehicle to make sure the brakes are working correctly. Make 2 or 3 ABS assisted stops to ensure proper system operation. Completed ❑

44. Clean your work area and return all equipment to the proper storage locations. Completed ❑

45. Ask your instructor to review your work and to sign this job.

Instructor's Signature _____

Job 10

Air Bag Service

Name: _____

Date: _____

Instructor: _____

Score: _____

Objective: Given the proper tools and equipment, you will learn to service an air bag system.
Tools and Equipment: You will need an appropriate scan tool, a set of hand wrenches, screwdrivers, and safety glasses.
Instructions: Perform this job only on the air bag system of an instructor-prepared shop-owned vehicle that has had one of the wires to the air bag module permanently disconnected to prevent accidental deployment. *Do not* perform the following procedures on a vehicle with a "live" air bag. You should study Chapters 20 and 28 in your text before starting this job.

Warning!
Take care to avoid accidental air bag deployment when working. An air bag has enough force to break bones and cause serious injury. Keep your head and arms to one side of the air bag when testing circuits, removing an undeployed bag, disconnecting sensors, and doing similar tasks. Never place your head close to the steering wheel or reach inside the wheel spokes during service.

Scanning an Air Bag System

1. Start the vehicle and watch the air bag indicator light. It should go out several seconds after the vehicle is started.

   What does the indicator look like on the vehicle being serviced?

   _____

   _____ Completed ❑

2. Does the indicator light go out after the vehicle is started? _____ Completed ❑

3. If the air bag indicator light stays on after the engine starts, connect a scan tool to the vehicle's diagnostic connector and retrieve trouble codes. Completed ❑

4. Were there trouble codes present in the system? _____ Completed ❑

   If so, list them. _____

   _____

   _____ Completed ❑

Disarming an Air Bag

5. Disarm the air bag system according to the manufacturer's recommendations. Procedures vary with the vehicle make and model. Always refer to the service manual for exact procedures for disarming the system. See **Figure 1.** Completed ❑

6. Explain how you disarmed the air bag system on the vehicle at hand.

   _____

   _____ Completed ❑

Warning!
Air bag systems are often equipped with an energy reserve module, which can deploy the air bag after a power failure. The energy reserve module must be allowed to discharge for up to 30 minutes after the battery has been disconnected. Refer to the service manual for details.

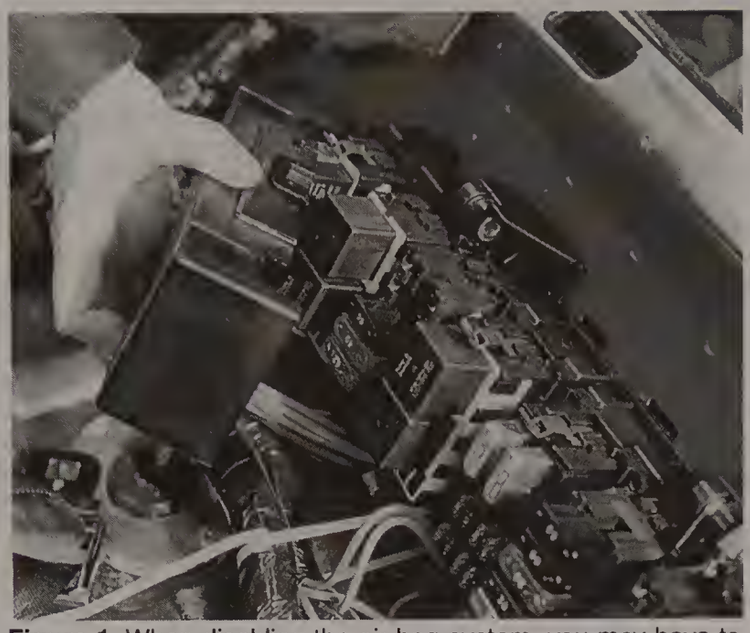


Figure 1. When disabling the air bag system, you may have to remove a fuse, disconnect the module, or disconnect the battery. Refer to the manufacturer's service manual for specific instructions.

Air Bag Removal

If this were an actual repair, you may be required to remove and dispose of a deployed air bag. In this job, however, you will remove and replace an air bag module from a steering wheel.

> **Warning!**
> Keep your arms out of the steering wheel spokes and your head to one side of the steering wheel when working on an undeployed air bag. An air bag can shatter bones if accidentally deployed.When carrying a live (undeployed) air bag module, aim the trim cover or bag away from your body. The metal housing should face your body. When placing the air bag module on a workbench, the bag and trim cover must face upward. This will reduce the chance of injury if the bag accidentally deploys.

7. Remove the screws from the rear of the steering wheel. Completed ❑
8. Lift the module out of the steering wheel and disconnect the wires. Completed ❑
9. Inspect the steering wheel, steering column, and related parts for problems. Parts that have visible damage should be replaced. Damage to the wiring may require wiring harness replacement. Completed ❑
10. Did you find any damage to the steering wheel or column? _____

    Explain. _____

    _____

    _____ Completed ❑

Air Bag Installation

11. If needed, service the clock spring that connects voltage to the air bag module through the steering wheel. Completed ❑
12. Was clock spring service needed? _____

    Explain. _____

    _____ Completed ❑
13. Before reinstalling the air bag module, double-check that all sources of voltage have been disconnected. You do not want the air bag to deploy when you reconnect its wires in the steering column. Completed ❑

14. Reinstall the new air bag module. While keeping your head to one side of the bag, reconnect its wires. Fit the unit down into the steering wheel. Completed ❑

15. Reinstall the small screws that secure the module to the steering wheel. Completed ❑

Note!
Most manufacturers recommend using new screws after air bag deployment, since the old ones might have been damaged by deployment.

Air Bag Sensor Service

Note!
After deployment caused by a collision, some manufacturers recommend that you replace all the air bag sensors. Some sensors will remain closed after a collision and will fire the replacement air bag as soon as power is reconnected.

16. Before servicing any air bag system sensor, make sure the system is disarmed. If you try to remove an air bag sensor with the system armed, the air bag could accidentally deploy. Completed ❑

17. Refer to the service for information on sensor locations, wiring diagrams, and specifications. Air bag sensors are usually located in the front of the engine compartment and under the dash or console in the passenger compartment. Completed ❑

18. Where are the sensors located on the vehicle being serviced?

Completed ❑

_____

19. Disconnect the wiring from the sensor. Completed ❑

20. Remove the screws holding the sensor to the vehicle and then remove the sensor. Completed ❑

If this were an actual repair, you would replace the sensor. For this job, however, you will simply reinstall the sensor. When replacing a sensor, be sure to compare size, shape and external markings.

21. Reinstall the sensor in the same position. Any arrow stamped or printed on the sensor must point toward the front of the vehicle. If you install a sensor backwards, the air bag will not deploy during a frontal impact. Refer to **Figure 2.** Completed ❑

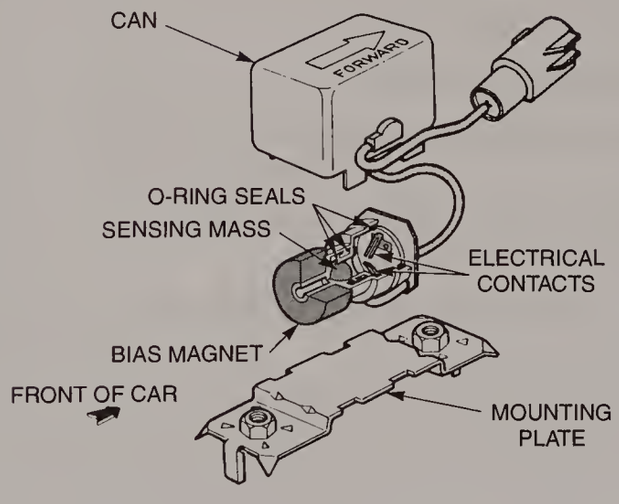


Figure 2. When installing an impact sensor, make sure any arrows on the sensor point toward the front of the vehicle.

22. Tighten the sensor screws properly and reconnect the wiring connector. Completed ❑

Note!
After replacing the sensor, you must rearm the air bag system. Refer to step 27 for details.

Air Bag Controller Service

23. Before servicing the controller, make sure the system is disarmed. Completed ❑

Warning!
Some controllers contain the main impact sensor for the air bag. If the system is not properly disarmed and you move or jar this type of controller, the air bag could accidentally deploy.

24. Disconnect the wiring harness from the controller. Do not force the connector from the controller. This can damage the connector or its pins. Completed ❑

25. Remove the screws that secure the controller. Completed ❑

If this were an actual repair, the controller would be replaced. For this job, you will be reinstalling the controller. Completed ❑

26. Reinstall the controller in reverse order of removal. Completed ❑

Rearming the Air Bag System

27. With everyone out of the vehicle and away from the air bags, rearm the air bag system according to the vehicle manufacturer's instructions. Completed ❑

28. How did you rearm the system? _____

_____

_____ Completed ❑

29. Use the scan tool to make a final check for trouble codes. Completed ❑

Note!
If this were an actual repair, no trouble codes would be present if the system was properly repaired. Since the system you are working on was intentionally disabled, there will be codes present when you scan the system

30. List any codes displayed by the scan tool.

_____ Completed ❑

31. Start the vehicle and observe the air bag indicator lamp. Completed ❑

32. Does the lamp go out after the specified amount of time? _____ Completed ❑

33. Clean your work area and return all equipment to the proper storage locations. Completed ❑

34. Ask your instructor to sign this job.

Instructor's Signature _____

Job 11

Name: _____

Date: _____

Instructor: _____

Score: _____

Filling out a Repair Order

Objective: After completing this job, you will be able to fill out a repair order.

Tools and Equipment: You will need one of your completed job sheets, a flat rate manual, a parts catalog, and a pen or pencil.

Instructions: As you read this job, fill out the repair order on page 315 of this workbook.

Completing a Repair Order

1. Select a repair you performed earlier in this class, ask your instructor to summarize a repair for you, or have your instructor to assign a repair. Completed ❑
2. Fill out the customer information section of the repair order. Be sure to include the owner's name, address, and phone number; the make, model, and year of the vehicle; the vehicle's mileage; and the vehicle identification number. Completed ❑
3. In the *Instructions* column of the repair order, write down the cause of the problem and what was done to correct it. Completed ❑
4. In the *Parts* column, list all parts used in the job. If there are part numbers available, be sure to record them. Completed ❑
5. List the retail prices of all the parts in the *Amount* column next to the part names. To find parts prices, refer to the original receipts, look in catalogs, or call local parts suppliers. Remember that the customer pays retail (not discount) prices. Completed ❑
6. Add the prices of all parts and list this amount in the *Total Parts* box in the lower right-hand corner of the repair order.
   A. What is the total retail price of the parts? _____
   B. What is the total discount price of the parts? _____
   C. How much profit would the shop make on parts alone? _____ Completed ❑
7. If an outside shop performed any work, list the type and cost (amount) in the *Sublet Repairs* section. List each sublet repair separately. Completed ❑
8. Add the costs of all sublet repairs and record this amount in the *Sublet Repairs* box in the lower right-hand corner of the repair order. Completed ❑
9. Use a labor rate manual to find the amount of time needed to complete each task listed in the *Instructions* section. List the repair time for each task in the *Time* column next to the corresponding task. Completed ❑
10. Ask your instructor to assign a labor rate for this job. What is the labor rate for the job? _____ Completed ❑
11. Determine the labor cost for each task by multiplying the labor time for the task by the labor rate. Write this labor cost in the *Amount* column next to the *Time* column. Completed ❑
12. Add all the labor costs and list this amount in the *Total Labor* box in the lower right-hand corner of the repair order. Completed ❑

13. Determine a reasonable fee for shop supplies, such as cleaning fluids and shop towels. If necessary, ask your instructor to suggest an amount for this job. Record the shop supply fee in the *Shop Supplies* box on the repair order. Completed ❑

14. Determine whether this job would require the disposal of hazardous wastes (oil, batteries, etc.) and, if so what the cost to the customer would be. Write this amount in the *Environmental Fees* box in the lower right-hand corner of the repair order. Completed ❑

15. Add the cost of parts, labor, shop supplies, environmental fees, and sublet repairs together to determine the total pretax price of the service. Record the price in the *Total* box in the lower right-hand corner of the repair order. Completed ❑

16. Determine the sales tax rate in your area. Completed ❑

17. Multiply the total pretax price of the service by the tax rate to determine the amount of tax that should be charged. Record this number in the *Tax* box in the lower right-hand corner of the repair order. Completed ❑

18. Add the number in the *Tax* box to the number in the *Total* box. List this amount in the *Total Amount* box. Completed ❑

19. Have your instructor check your work and sign this job.

Instructor's signature: _____

Job 11 Filling Out a Repair Order 315

Name _____

Duff's Garage

442 Express Drive
Speedway, IN 12345
Phone: 555-5555

Customer's Name: _____
Address: _____
Phone No: _____
Vehicle Make and Model: _____
Model Year: _____
VIN: _____
Odometer: _____

Qty.	Parts	Amount	

Instructions	Time	Amount	

Sublet Repairs	Amount	

Total Labor		
Total Parts		
Shop Supplies		
Sublet Repairs		
Environmental Fee		
Total		
Tax		
Total Amount		

I hereby authorize the above repair work to be done, along with the necessary material, and hereby grant you and/or your employees permission to operate the vehicle herein described on streets, highways, or elsewhere for the purpose of testing and/or inspection. An express mechanic's lean is hereby acknowledged on above vehicle to secure the amount of repairs thereto.

Work Authorized by: _____ Date: _____

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